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LECTURES

on

Chemistry

by

Joseph Black M.D.

VOL. V.

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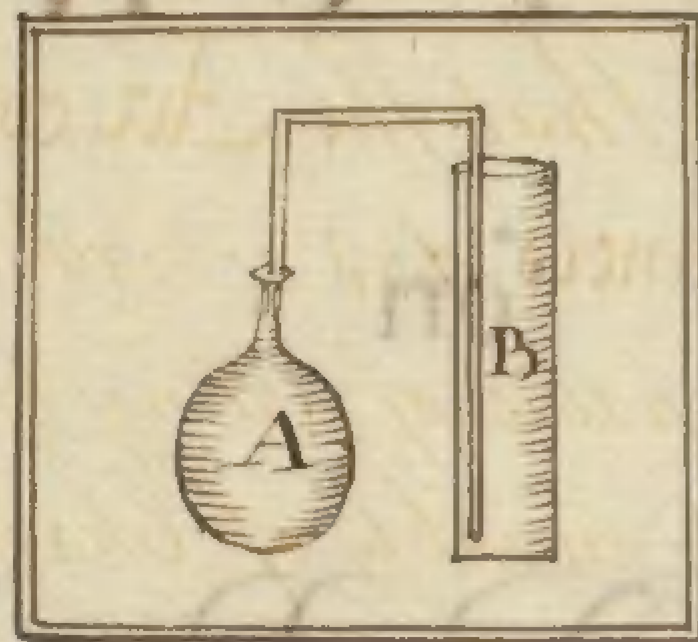


A
B

Lect: 61st

To shew that the Air contained in Alkaline Substances does actually extinguish Flame, & is capable of killing breathing Animals, I put a quantity of Chalk & Water into this Cylindrical Glass Vial (A) & pour into it some diluted Vitriolic Acid, which produces an Effervescence, separates & expells the Air united with the Chalk, throws it off loose, & restores it to its Elastic State; & while it arises from the Chalk, the common Air wh the Vessel contained is gradly driven out, & after we have added a certain q.y of y Acid the Vessel will be filled with this Air, wh is conveyed by a tube into the cylindrical Vessel (B), from wh the atmospheric Air has been expelled by burning a piece of Paper in it.

We can't observe any Change produced in the upper part of the Vessel, it is still

transparent, but upon examining it a little, we shall soon find it to be different from common Air; for it will continue some time in the Vessel, tho' it be open, but the least Agitation of the surrounding Air will occasion it to disperse; & upon immersing a Candle into it, the moment the flame sinks below the level of the Vessel it is extinguished, tho' sometimes the flame hovers over the Wick at a little distance; a Smoak only is seen to arise from the Wick, & at a certain height appears in flame; for flame is only Smoak in a State of Inflammation; & this kind of Air being unfit for contributing to the Inflamm.^{n} the part immersed in the fixed Air appears in the form of Smoak, while the part getting up into the common Air is set on fire.

I said that this fixed Air is sensibly heavier than common Air, w.^{c} will appear from a very simple Exper.^{t} Upon opening the Vessel & suddenly inclining it, it will run

out like Water & by pouring it on a Candle it will extinguish it, & this may be repeated 2 or 3 times. And if a small Animal, as a Mouse, be let down into this Air, it will be immedly suffocated.

Some other Gentlemen have made an Enquiry into this Sort of Air. Dr. McBride at Dublin has considered it as an Element of great Importance, supposing yt the Cohesion of bodies depends upon it, & that Putrefaction & the Dissolution of bodies depend upon its Separation. But later Experts have not supported this Idea, & he appears to carry it too far. There is some Probability of its being a Cementing Principle of Animal & Vegetable Substances, particly of the Vegetable, but still the Arguments are by no means very strong, for when they are reduced to Corruption all the other Principles also separate from one another, & it is the nature of this Corruption to be attended with the Separation

of all other Principles, so that it is not surprizing
y.t this Principle sh.d separate among the
rest; & its particular quality is to fly off
among the first. But to imagine y.t this
is the Principle of Cohesion of Min.l Substances,
is certainly very absurd, because many of them
don't contain the smallest particle of it in
their Composition — With reg.d to Animal
Substances, that Elastic Matter arising when
they are putrefying is not this Air, but an Inflam.le
Vapour, at least the q.ty of this is but small.
Some Exper.ts have been made upon this Air
by the Hon.ble D.r Cavendish, in the Philosophi-
cal Transactions he has shown it to be a
permanently Elastic fluid, he kept it 12
Months in a Vessel, the Mouth of w.ch was con=
verted into Mercury, & did not observe any
change upon it; he has also shown its man-
ner of uniting with Water, w.ch can absorb
a q.ty of it. M.c Bride has also shown
this, & y.t it is capable of precipitating the

Lime from Lime Water; but Cavendish has shewn this more clearly, & has determined the qty, that when the Water is in a middle State of temperature it will absorb more than an equal bulk of this Air, if it is warmer not so much; & throwing in as great a qty as it can receive & heating it to a certain degree it will come out in bubbles, appearing like a fermenting Liquor. It also flies off if the Water is exposed to the Air in an open Vessel. He also found yt other Liquors, as spt. of Wine & some of the Oils, received it. He likewise found yt this Air was not homogenious, & yt some parts could be absorbed more readily than others, but this might proceed from common Air. It was attracted by Marble, Pearl Ashes, &c & in precipitating these Earthy Substances from Acids by an Alkali an Effervescence is produced, the Alk: containing a larger proportion of Air than the Earthy Substances can

attract & unite with. He also examined the precise density of this Air, & found y.t it exceeded the Specific Gravity of common Air about one half.

All these Circumstances are ascertained in a sett of very ingenious Exper.ts which are worthy of your Attention. Some of these Exper.ts attracted the Attention of Dr. Brownrig to a Subject w.h he had been considering before, Viz.t that the Mineral Waters, called Acidulae, like fermenting Liquors, derive their quality from a q.ty of this Air, w.h is found to abound in the Caverns in the Neighborhood of these Waters, & is called Choak Damp, & he gave a full Demonstration of this to the Royal Society from a n.o of Exper.ts on the Waters of Spaw. He separated the Air by tying a bladder on the Mouth of a bottle containing it, & applying heat, when that sort of Air came out, & being received into other Vessels it shews its nature by extin-

extinguishing

quishing flame & killing Animals, & being mixed with Lime Water is readily precipitates the Lime. These Exper^ts. have been confirmed by a n^o. of others made by D^r. Gaen of Sweden; & he has also made Exper^ts upon some kinds of Air occurring in several Caves & Caverns in the Neighborhood of Spaw, w^ch he found to be readily attracted by alkaline Substances. From these Exp^ts. of D^r. Brownrigg we have an Explication of some of the qualities of the Mineral Acidulae, of that slightly pungent Acid Taste, & of briskness w^ch makes them sparkle in a Glass, w^ch soon goes off again.

Further, some Exper^ts. made by Cavendish & others, communicated in the Philosophical Transactions by Lane an Apothecary at London, shew that the Waters at Rathbone place, &c. w^ch are noted for containing a considerable q^ty of Calcar^s. Earth, w^ch incrusts Tea kettles, &c. contain a certain q^ty of this sort of Air,

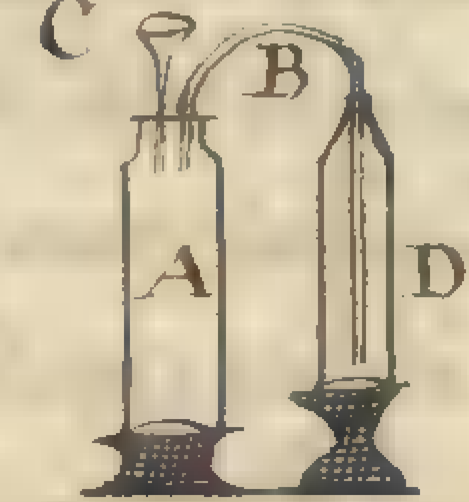
which unites with the Calcar.s Earth in Super-abundance, & w.ch is the Principle upon w.ch the Solution depends, & that the Water deposites the Earth in consequence of y.e heat chasing away the Air w.ch held y.e Calc.s Earth dissolved, & they found y.t they could make an artificial Water of this sort, by throwing in a q.ty of this sort of Air, w.ch then dissolved a q.ty of the Calcar.s Earth — This explained the nature of these Waters, w.ch are so remarkable for their petrifying quality. While they flow under the Earth they contain this Calcar.s Earth dissolved, but when they are exposed to the Air with an extensive surface, as where they run over a Moss or on y.e side of a Bank, they incrust these & penetrate them with Calcar.s Matter. It was imagined that the Calcar.s Earth was suspended by Mineral Acids, & we could not understand how this Earth was deposited. But from its being dissolved by this new Substance, it

was easily understood because when exposed to the Air this Principle grad^y flies off, so y^t the Water must deposite^t the Calcar^s Earth, & therefore we need only to introduce this Air into Water & filtrate it thro' a spongy Mass of Calcar^s Earth w^c will dissolve it, & this Earth will again be deposited when the Solution is exposed to the Air.

There are also Medicinal Waters which become milky or muddy when exposed to the Air, & many of these are found to contain Air w^c is liable to seperate even more readily, w^c was not understood till M^r Lane published his Exper^ts. He found y^t Iron might be dissolved in the same manner when introduced in its Metallic State. When diffused in Water containing a q^ty of this Air it dissolves in such q^ty as to give the Water a strong taste resembling that of the Waters of Spaw, & the Chalybeat Waters. And an artificial Chalybeat thus prepared has all the qualities

of the natural Chalybeats. When this Sort of Water is taken from the Spring, if it is not kept in Vessels closely & well secured from any Communication with the Air, the Iron is deposited & the Water loses the Power of striking a black Colour with Galls. Mr Lane imitated this Water exactly by means of this sort of Air introduced, it dissolving a part of the Iron wch was liable to separate soon again, so all the most difficult Phenomena belonging to Mineral Waters have been explained from this Principle.

The only other Communications on this Subject are those published by Dr Priestly, who gave a Process for uniting this sort of Air with Water, but in this Process there is nothing new except the Addition of a bladder wch I myself & others had used long before. The Apparatus may be very simple, we need only a Vessel (A) in wch a qty of Chalk is mixed & to wch some Acid is applied, & a


C
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communication made between this Vessel & another. I have the Vessel containing the Chalk & Water fitted with a cork w^ch is perforated with 2 holes, into one of w^ch the short Leg of a Syphon (B) is introduced & into the other the Pipe of a small funnel (C), by w^ch we introduce some Vitriolic Acid, & the Pipe of it is so small y^t it falls by drops into the Chalk & Water, in Consequence of w^ch the fixed Air rises up, drives off the common Air, & passes thro' the Syphon, the Extremity of w^ch descends near to the bottom of the othe Vessel (D) containing the Water.

Mr. Preistly's contrivance of the bladder was to give an opportunity of agitating the Water into w^ch the fixed Air is introduced; but if the Pipe is long enough to reach near the bottom a part rises up in bubbles & the whole of y^e Water soon becomes impregnated with it, & we have an Artificial Piermont Water.

In the last Vol: of the Transactions we have

a nº of Exper^ts on Elastic fluids & fixed Air, 11 several properties of this Air of w^ch we are now speaking are taken notice of, but most of the Exp^ts are upon other kinds of Air w^ch we shall take notice of hereafter.

Upon the whole this sort of Air is quite distinct from common Air, tho' it is con^tly mixed with the Atmosphere in small quan^ty.

With regard to its Origin, when treating of the Inflam.^le Substances & Metals I shall consider this more partic^ly, & now only hint the Opinion of its being Vital air changed by the Communication of some Matter, seemingly the the Pr. of Inflam^y. This appears from several Phenomena, as when an Animal or burning body is inclosed with a certain q^ty of this Air till they have changed it as much as possible, upon exam^g it, it is not increased in bulk; thus, if we invert a large Glass Vessel into a flat Vessel contain^g Water, & then introduce a burning body or breathing Animal

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still the Air is tainted as far as it can be for continuing the Inflamn. or supporting the Life of the Animal, provided we allow the Air to return to its first temperature & examine it, we will find it diminished in bulk, a part of the Water is forced up into ye Glass by the Action of the burning body or breathing Animal, is not added but that a part of the Air wh. the Glass contained is changed into fixed Air by some Addition made to it; & this seems to be farther confirmed by an Expt. of Mr. Priestley's, in wh. he found yt. growing Vegetables had the power of restoring this Sort of Air to common Volatile Air again, wh. must be done by taking away from it some Matter wh. it had received, & had been tainted with, from the burning body or living Animal.

TO return now again to the Expts. in proof of the difft. Propositions deduced as Consequences from the Theory of Quicklime, we are next to consider the

4th Proposition, which relates to ye Lime supposed to be contained in ye Caustic Alkali.

I began by evaporating a qty of Soap Lee to dryness, & it was even melted by increasing the heat, & then applying Water to dissolve it again I saw an Appearance which made me imagine yt an Earthy part was separated from it, it appeared in the form of small gritty Particles like Sand, but upon exam[in]g these more attentively they were not Sand nor any Earthy Matter but a Vitriolated Tartar, having used Pearl Ashes, wc is always attended with a qty of this Vitriolated Tartar, & this begins first to crystalize, & when ye Water was applied it remained undissolved, requiring a great deal of Water to its Solution, but upon adding more Water it readily dissolved, & shewed itself plainly to be this Vitriolated Tartar. The Vitriolic Acid is a sort of Test for discovering this sort of Matter, always forming with it a Selenite, so if the

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Caustic Alkali contained Lime it might be discovered by the addition of this Acid. I therefore made this Exper.t There was also an Appearance liable to deceive a person, the Mixture became muddy & deposited a sandy powder, but that was also a Vitriolated Tartar, w.^ch upon adding more Water was readily dissolved; so I could not discover the smallest particle of Lime in the Alkali. Nay what was more, I exposed a q.ty of Caustic Lee to the Air till it was restored to its mild State. Now if this Sharpness depended upon the Lime adhering to it, I had reason to be satisfied y.t that Lime must be separated when the Alkali returned again to a mild State. Upon being exposed to the Air, it very quickly attracted the Air, it every day effervesced more & more with Acids, till it was fully as mild as any Ordinary alkaline Salt; yet at the end of a fortnight there was not the least Appearance of any deposition of Lime, so y.t

[illegible]

we may certainly conclude yt the Caustic Alkali does not contain Lime, or that Lime is not an essential part in its Composition.

I indeed expected some Lime, as I was obliged to use a great deal of Water, wc I expected shd have dissolved a qty of it, but not finding the least Atom of Lime, I began to consider the manner in wc this happened, & from the genl Principles of Elective Attractions it appears yt the Water, as it containd the Caustic Vol: Alk: was indisposed to unite with or dissolve the Lime. I satisfied myself yt this must be the Case by adding to Lime Water a Substance having a pretty strong Attraction for Water, as Spt of Wine, & upon making the Mixture, it becomes turbid & was found to be owing to the Separation of the Lime in its active State. It was not deposited in conseqce of its receiving Air from the Spt of Wine, it being free from any such Air, but merely because the Spirit

is not a Solvent of Lime; & it acts so strongly upon the Water as to take away from it the power of keeping the Lime suspended.

5.th Proposition. The last of these Propositions pointed out a Method of converting the Calcar.s Earth into Quick Lime without the aid of fire. I took some Epsom Salt & dissolved it in a small q.ty of Water, & mixed it with a small q.ty of Caustic Lee, all the Magnesia was precipitated like a starchy Sediment, & was found to dissolve in Acids without Effervesence as if deprived of its Air before. Sect. 62.d

In repeating a similar Exper.t with the Calcar.s Earth, I took ℥ß of Chalk, dissolved it in Muriatic Acid, using no more of the Acid than what was just sufficient for saturating the Acid, & mixing the two Liquors they became turbid, & the Limy Matter of the Chalk was precipitated, I then

laid the Powder on a Chalk Stone to drain off the Water, & mixed it with about 20 ℥ of distilled Water in a flask, & shaking the Powder for some time I poured off the Water, wh had all the qualities of Lime Water, but containg a saline Matter. I repeated this 7 times, allowed the Water to remain a long time, then filtrating it I examined & found it to have every property of Lime Water, so yt I could not have distinguished it from one made from Lime calcined by fire, & I found yt the Lime at the bottom still retained some Acrimony, so yt I was satisfied that the Calcar: Earth was by this Process converted into Quicklime, wh must have been the Case from what happens on this occasion, for ye Chalk being dissolved in ye Acid the Air was expelled, & we had a Comp:d of pure Earth & Acid, the Caustic Alkali again upon being added, without communicating any thing to the Chalk, so yt the Chalk appeared

in ye form of a Q: Lime or rather slacked Lime.
Therefore it is plain from these Experts that the Calcar: Earth was converted into Q: Lime, & yt the Alkalies when rendered Caustic are deprived of something; & yt it is not any of the alkaline Matter is evident from their satu-rating as much Acid as before; & yt it is Air appears from the Experts of Margraaf upon the Osteocolla; & from their not effervesing with Acids; & by contriving a new way of separa-ting the Air from the Calc: Earth, it was rendered active & appeared in the form of a slacked Lime.
The same is true of the Vol: Alk: wch may be obtained free of Air by a greater Variety of means in Conseqce of its Volatility, & in what-ever way we have it free of Air, it is always Caustic, & in a liquid form, as by decomposing Sal Ammoniac by Quicklime wch attracts the Acids, & the real Alkali is separated in its pure State consisting of a very Volatile & acrid

Alkali, w^ch is incapable of appearing in a solid form, but requires the Assistance of Water in its Condensation. The Caustic Vol: Alk: may also be got from Sal Amm^c by adding the Caustic fixed Alkali.

But what appears most curious is a way of obtaining Vol: Alk: in a Caustic State from the essential Salt of Urine, w^ch contains Vol: Alk: in its Composition, but combined with a very singular saline Substance, having the qualities of an Acid, but w^ch endures the strongest red heat without assuming y^e form of Vapour, it is only melted into a viscid fluid like Glass. Margraaf therefore discovered y^t the Alk: might be decomposed by the simple application of heat, the Vol: Alk: having but a moderate Attraction for y^e Acid when the heat is raised to such a degree it acquires such a disposition to assume the form of Vapour y^t it rises in Vapours w^ch may be condensed by themselves but can't

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be condensed in a solid form. Some have imagined that the Causticity was owing to something communicated to it from the Acid, but we can dissolve the Acid in Water & mix it with fresh Vol: Alk: if that contains Air it Effervesces & we get an Ammoniacal Salt plainly the same as before, wch shews yt the Acid has undergone no change, & we can decompose this as we did the first, & we can have the Alkali in its Caustic State. And there is no doubt yt if we separate the fixed Alk: from an Acid without its getting fixed Air we sh.d have it in its Caustic State, but there is no Example of any Operation in Chemy by wch this can be effected, the Alk: adheres too strongly to the Acid. There are only 2 Operations wch appear to be of this kind — 1st The decomposition of the Nitre by burning Charcoal, there is a

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violent deflagration & the Alk: remains,
but this is by no means in a Caustic
State; we find y^t it effervesces violently w^t
Acids & seems to get the Air from the
Charcoal or perhaps from the Acid also;
at least it is certain y^t by their Action
they produce a large q^{ty} of Air, part of w^{ch}
is attracted by the Alkali. The other Ex-
ample is the Separation of the Alk: from
the Regenerated Tartar or the other Salts
containing the Vegetable Acids in their Com-
position; for having a fixed Alk: we ex-
pose them to a scorching heat, w^{ch} de-
stroys the Acid & leaves y^e Alkali remain-
ing, but it is not in its Caustic State, but
contains a large q^{ty} of Air; & the Acid on
this occasion is not separated by the heat,
it is totally lost & destroyed, the Arrange-
ment is totally confounded & new Pro-
ducts arise, w^{ch} contain a q^{ty} of Water,
some Oil, & sometimes a small portion
of

of the Vol: Alk: which did not appear in the Compound Salt before, & among these Principles into wch the Vegetable Acid is resolved, is this qty of fixed Air wch is found adhering to the Alkali.

Let us next consider the different ways by wch this may be rendered mild, & whether this be not always by the restoration of their Air, it is done by Exposition to the Air, & this is found to contain fixed Air, or by adding an Alkaline Salt or Magnesia, both these contain fixed Air in abundance. The Caustic Vol: Alk: can't be exposed to the Air without flying off, but we can render it mild by first saturating it wt an Acid, to reduce it to the State of an Ammoniacal Salt, & decomposing it by the Vegetable fixed Alk: or Crude Calc: Earth; these Substances communicating Air to the Alk: when they attract the Acid from it, or the Air arising from Chalk and

Water upon the addition of the Vitriolic Acid may be introduced into a qty of the Caustic Vol: Alk: in the same manner as we introduce it into a qty of Water, when we do this we can observe the Signs of a manifest quick absorption of a Vapoure, there is a kind of Motion like yt produced by 2 Liquors of unequal density, as in the mixing of Spirits & Water, or Syrup & Water, & I've observed heat produced from this Action of the Vol: Alk: and Mephitic Air, & now the Alk: is easily separable from the Water, in a certain degree of heat it arises before the Water & can be condensed by itself, the fixed Air uniting wt it, neutralizes it, represses its Volatility & diminishes its attraction for Water, & gives it a greater disposition to solidity, & upon saturating it with an Acid it effervesces violently; but in trying if it effervesces it may be proper to distill it with a

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little Water, as by the Violence of their Union there is a sort of Tremilus produced, a sort of Ebullition.

When we now view the Effervescence of alkaline Salts in this light we will find no difficulty in explaining the Phenomenon remarked by Boerhaave wt. surprize, viz.t the particular manner in wh. an Alkali effervesces with a weak Acid, as the Sedative Salt or common distilled Vinegar. This Phenomenon may be explained by considering the fixed Alk: as not perfectly saturated; so the part of the Alkali wc. wants the Air will on yt. Accot. have the stronger Attraction for the Acid, & unite with the Acid first added, & yt. without Effervescence, or tho' the Acid sh.d unite with some parts of the Alkali containing Air, as soon as the Air is separated it is again absorbed or attracted by these parts wc. are free of Air & most saturated; then if we add more Acid an

Effervescence will take place in the usual manner, & this partic^r. manner of effervesing is especially remarkable in the Case of weak Vegetable Acids, the force of whose Attraction for the Alk: is not much greater than y^t. of the Air, whereas the Attraction of y^e mineral Acids, as the Vitriolic, is so great for the Alk: & is so much superior to y^t. of the Air y^t. it acts with equal readiness upon the pure & saturated parts of the Alkali, the presence of the Air being no Impediment to it. This Explication indeed proceeds from y^e Suspicion y^t. the Alk: in its ordinary State is not perfectly saturated with Air, & it is easy to prove y^t. this is the Case.

There are several ways by w^ch. the Alk: may be saturated w^t. Air, as by exposing it in a broad & shallow Vessel to the Air for some time, or by exposing it to the Air arising from ~~fer~~ burning bodies, as Charcoal, or by dissolving it in Water & adding a q^ty of the mild Vol:

Alk:, wh readily parts with its Air to ye fixed Alkali. I took a qty of common fixed Alk: & exposed it to the Air in a shallow Vessel for some Weeks, I found yt it had attracted Air, yt a no of Crystals were formed, consisting of a part of the Alk: neutralized to a greater degree by fixed Air than it comly is, & resembling the Neutral Salts. In this State ye Alk: is very mild to the Taste; requires a great deal of Water to its Solution, & we can't now add it to the weakest Acids, but an Effervescence takes place from the beginning.

Upon examg the difft fixed Alkalies we shall find yt they differ considerably from one another with regd to the qty of Air; the mildest is genly a Salt extracted from Tartar, wh is burnt merely to a black Coal in no greater degree of heat than what is sufficient to ~~tt~~ destroy the acid.

The same is pretty much the Case with the Alk: of the black flux wh contains a great

qty of Air. The other fixed Alkalies contain less Air; after these Pearl Ashes contain rather less air than the black flux, & the white flux contains still less.

Next Vol. Ashes, the strong heat necessary for preparing these dissipating a great part of the Air of the Vol. Alk, the mildest is the Sal Ammc. Volat: decomposed by preparing Sal Ammc. with Chalk.

Next to this the Salt of hartshorn, but in the Process for obtaing it a part of the Vol. Alk. rises in a liquid form & is tainted wt. a qty of burnt Oil, & called Spt. C. C. & this is found to be more in a Caustic State; & can hardly be brot. to a State of Solidity. The Oil in its Composition hinders it from so readily attracting Air & assuming a solid form.

Next the Vol: Alk. separates from ye Sal Ammonc. by a fixed Alk, wc. contains but a small qty of fixed Air, & it is necessary to use some Water in the Process to condense it,

& the Product is called Spt. of Sal Ammoniac.

So far therefore the Principles we have delivered, concerning ye Nature of Q. Lime & alkaline Substances in genle., into wch the Calcarr. Earth are converted have assisted us to explain all the Phenomena relative to the Subject. Very few Theories are free from every sort of Difficulty, & none have ever occurred wt. regd. to this Subject except one, & when this is better understood it will entirely vanish. If the mildness of Alkalies & Calr. Earth depends upon Air adhering to them, to make them Caustic we need only to separate the Air. It may be thot. yt. the same degree of heat, sufficient to convert the Calr. Earth into Q. Lime, sh'd. reduce the fixed Alk: to a State of perfect Causticity, the Calr. Earth having a stronger Attraction for fixed Air than the fixed Alk. has. But from Experience it does not appear yt. it can be rendered perfectly Caustic by any Sect. 63.

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Application of heat. But it is not an Objection to the Theory, it is true y^t. we cant by heat alone render the fixed Alk. perfectly Caustic, neither can we entirely separate its Air & prevent its Effervescing w^t. Acids, neither is it difficult to give reasons why this Sh^d. be the Case, tho' it is true that the fixed Alk. has a weaker attraction for Air, & y^t. common fixed Alk. is capable of enduring a consid^ble. degree of heat, it will not approach to the degree necessary to the Calcinat^n. of the Cal^s. Earth, part of it is converted into Vapour, the rest corrodes the Vessel & is lost; besides, it is well known to the Chemists y^t. the fusion w^h. the Salt undergoes is an obstacle to the Separat^n. of the Vol: from the fixed parts by heat. However the alkaline Salts do acquire a very sensible degree of Causticity from being exposed to a strong heat. D^r. Boerhaave lays a great Stress upon this Preparation, he or-

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ders the fixed Alkali obtained from the Ashes of Vegetables to be exposed long to a strong heat, & he imagines y.t the greater Activity it hereby acquires depends upon the dissipation of an oily Matter, but it is attended with a proportional dissipation of Air; when in this State we can precipitate a Cal: Earth by means of it in the State of an imperfect Quicklime.

Some time ago seeming Objections occurred from the Consequences of mixing Tartar with Lime & Lime Water, but the nature of this Mixture was very little understood before Mr. Buckle explained the nature of Tartar, & we know that the facts started upon y.t Subject were not founded on Experience & just Observation.

Therefore after a careful consideration of the whole, the alkaline Substances present themselves in a new light; they were always considered as simple, & their several Powers in Mixture essential to them. But we

have reason to be satisfied y. they are Compounds of 2 Ingredients, wch are separable from one another, & this must be attended to in their Mixture wt. other bodies. Thus when an Alk. or absorbent Earth is united with an Acid wt. Effervescence, it is not a simple Attraction, there is the dissolution of a Compound by the addition of a 3d. Substance wch unites itself to one of the Ingredients. And when an Earth or Metal is precipitated from an Acid by an Alkali or one Earth by another, these are often Cases of double Elective Attraction, the Air in the precipitating body, uniting to the Precipitate or Vol. Alk. or other Matter separated from the Acid in this manner

It is therefore proper to consider the Relation of the several Alkaline Substances to this new Matter called fixed Air, particularly their different degrees of Attraction for it, to observe in what order they may be em-

ployed to separate one another, from it, as well as from other Acids.

— Table —

Fixed Air.
Quick Lime.
Fixed Alkali.
Magnesia.
Volatile Alkali.

This view of their relative Attraction for fixed Air arises from ye foll.g Observatns.

That Quick Lime has a stronger Attraction for fixed Air than the fixed Alk. appears from ye common Process by wch we obtain a fixed Alk. free of Air, Vizt. by mixing it with Quick Lime, wch attracts the Air & is rendered mild, so it must be set down before the fixed Alk. & also before Magnesia, for Magnesia being put into Lime Water occasions the Precipitation of the Lime, the Lime attracting the Air from the Magnesia & becoming mild, we have likewise Experience yt ye Qk Lime

attracts Air more strongly than the Vol. Alk, for mixing a mild Vol. Alk. with Q. Lime the Vol. Alk. is immedy rendered Caustic.

The next place belongs to ye fixed Alk. It has a stronger Attraction than Magnesia, by putting Magnesia into Caustic Lee the fixed Alk. attracts the Air & becomes capable of effervescing with Acids, or than the Vol: Alk: wc when put into Caustic Lee begins to arise in more pungent Vapours, & by Distillation we obtain a Caustic fixed Alk. from adding a Caustic fixed Alk. which attracts the Air — Next we find the Magnesia must be placed before the Vol. Alk. for if we put some Caustic Vol. Alk. to some Magnesia in its Ordinary State we don't find yt. the Alk. Attracts Air from the Magnesia, but when we add some calcined Magnesia to some Spt. of Sal Ammc the Magnesia attracts the Air.

But the Attraction of the same Substances

for Acids, turns out in the following Order.

Acids.

Fixed Alkali.

Quick Lime.

Vol. Alk. & Magnesia.

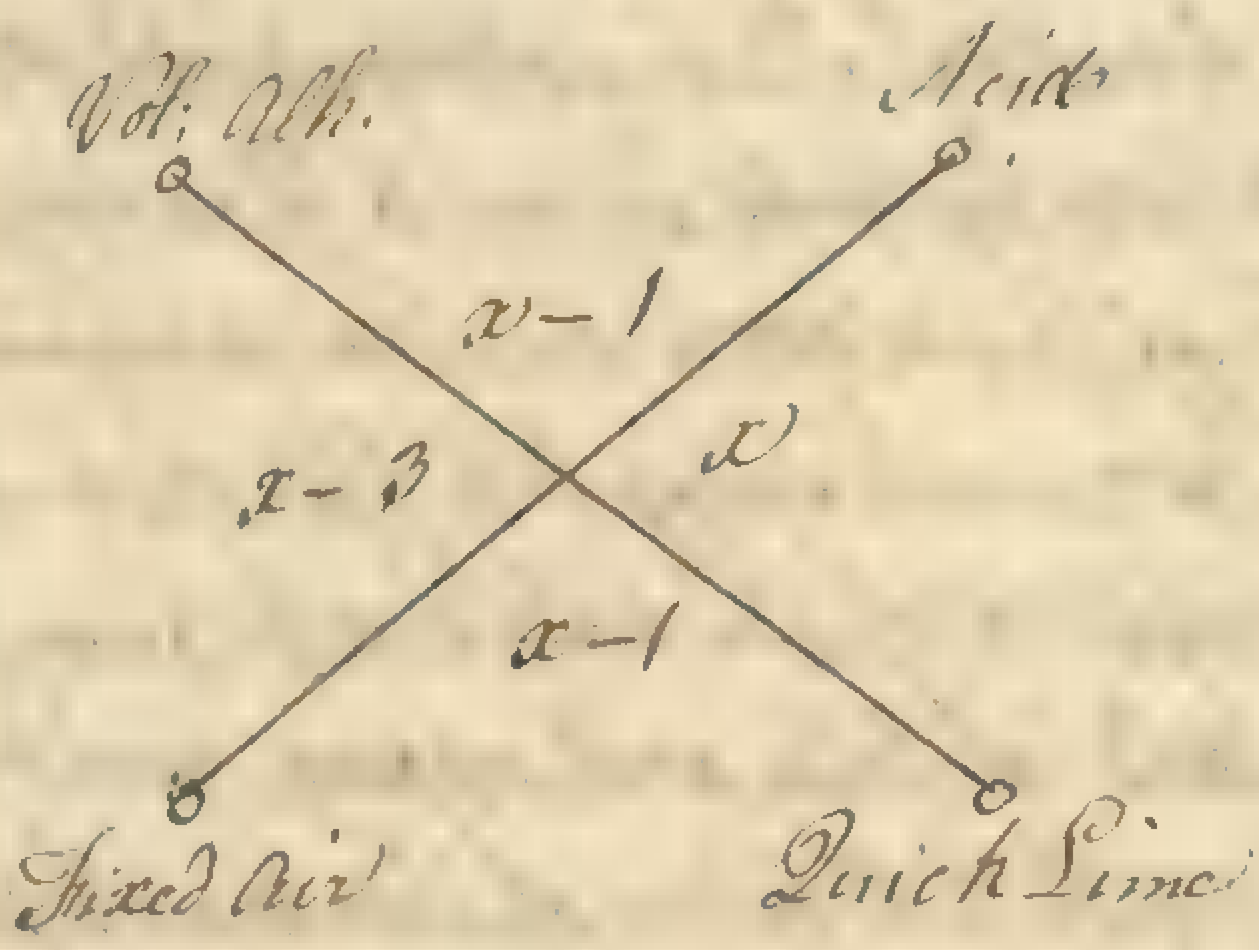
That the fixed Alk. has a stronger Attraction for Acids than Q. Lime, appears from the manner in wch we convert the Calc. Earth into Q. Lime without the aid of fire; & it readily separates either the Vol. Alk. or Magnesia from Acids — The 2d place belongs to Q. Lime; it attracts acids much more strongly than the Vol. Alk. as when we apply it to Crude Sal. Ammc. Perhaps it may be said yt. if we take a Solution of Calc. Earth in Acids & add some Vol. Alk. we shall see it attract the Acid, but this depends upon the Air wc the Vol. Alk. comly contains, for when we use it free of Air we observe no such thing, so yt. the Precipitation depends not upon the supposed Attraction of the Vol. Alk.

for the Acid but upon a double Elective Attraction while the Vol. Alk. attracts the Acid, the Cal.^d Earth attracts the Air & is disposed to part more readily with the Acid.

With reg.^d to the Vol. Alk. & Magnesia, I can't pretend to set down one before the other, from any Exp.^t I am yet acquainted with, their Attractions for Acids seems to be so very equal y.^t I set them down in the same Line.

From considering both these Columns, the Precipitation of the Cal.^d Earth from Acids by the mild Vol. Alk. will appear paradoxical, because y.^e Attraction of this Earth for the Acid is much stronger than any Attraction w.^ch comes into play, but yet it is weaker than the Sume of the 2 contrary Attractions, Viz.^t of the Vol. Alk. for the Acid, & of the Quick Lime for the fixed Air.

This will appear if we consider the Action of these 4 Substances upon one another in the manner I formerly taught you to consider


Vol: Alk.
Acid
x – 1
x – 3
x
x – 1
Fixed Air
Quick Lime

double Elective Attractions, Vizt by considering the 4 Substances as in the Situation of 4 Bodies placed at the Extremities of 2 Diameters of a Circle capable of revolving upon its Centre. We shall express the Action of Q. Lime & Acid by x. Next we must make the force of Attraction between the Q. Lime & fixed Air of ye Alkali less, because a Comp.d of Q. Lime & fixed Air is decomposed by an Acid, wc drives off the Air; so we must make ye force x–1. We next consider the force of Attraction between ye Acid & Vol. Alk., & it must also be less, because upon adding Q. Lime to an Ammoniacal Salt the Vol. Alk. is immedly separated, so it must be also x–1. Next we consider what to make ye force between ye Vol. Alk. & fixed Air, & it is plain yt it ought to be less than any 2 of these forces wc we have set down. It is less than the Attraction of the Vol. Alk. & Acid, because when an Acid is is added to the mild Vol. Alk. it drives off the Air & is united in its place. In like man-

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per it must be less than the Attraction of the Q. Lime for fixed Air, because upon applying Q. Lime to a Compd. of Vol. Alk. & fixed Air it attracts the Air, & farther it appears from the 2 Tables yt. the Vol. Alk. has but a weak Attraction for Acids, comes nearer to yt. of Quick Lime, so yt. its Attraction for Air will be less by 2 than its Attraction for Acids; now summing up the forces you'll find that the balance will be thrown in favor of the 2 forces united, thus the force of the Attractions of the Vol. Alk. & Acid is x-1, & that between the fixed Air & Lime x-1, i.e. they make 2x-2, while that between the Q. Lime & Acids is x, & that between the Vol. Alk. & fixed Air is x-3, i.e. they make 2x-3, so yt. the balance is in favor of the other, & you'll find ye Example of the Separatn. of the Calc. Earth from an Acid by means of Magnesia to depend upon the same Principles.

I have nothing farther to add but to

mention

mention a Dissertation upon Lime by one Meyer, a German Apothecary, who has revived the Supposition of an active Principle in Lime, & his Performance has gained some Credit. He describes the Exper^ts. I have mentioned, as his own; at least without mentioning their having been made by any other. He says y^t Quicklime contains the Caustic Principle communicated to it by the fire, & y^t it communicates it to alkaline Salts, & thereby renders them Caustic; he thus traces it thro' a Variety of bodies, & takes great pains to form some notion of it in a separate State; nay he describes a Process for obtaining it in its separate State; but I can assure you y^t he has either imposed upon the World, or been himself deceived by his heated Imaginations; he directs to take a Caustic Alkali, to saturate it with an Acid, then to distill the Liquor, & he thinks he found in the Liquor the Caustic Principle;

but we find Water only tainted with a burnt oily Matter, & perfectly free from the least Causticity wch is capable of communicating any thing to the alkaline Salt. He says this mixt with a Vol. Alk. increased its Sharpness, but he does not mention a single Expert by wch the Sharpness of the Alkali was ascertained.

This view wch we've taken of the Subject, besides giving us a clear Explication of the whole of the Phenomena, has been productive of several useful Consequences. By it the nature of Mineral Waters is better understood, & it admits of an useful Application to the purposes of bleaching, making of Soap, &c.

Upon this is founded a very easy Process for finding the Value of Marles, a Matter of great Importance to Farmers. These are only valuable in proportion to the qty of Calc. Earth they contain, a considerable

part of the Weight of w^ch is occasioned by the fixed Air in the Composition. By saturating the Marle with an Acid & observing the loss of Weight the Earth sustains while the Air is expelled, we learn the Proportion of Cal^s Earth it contains. Many Marles are used w^ch dont contain the 20^th or even the 30^th part of their Weight of Cal^s Matter; & a farmer by knowing the Value of a Marle can judge whether it is or is not worth his while to fetch Lime at a greater distance & at a better Price, the Effect of the same quant^y of Cal^s Earth in both being exactly the same. Thus, suppose the Marle contains only 1/20 of its Weight of Cal^s Earth, if the farmer can lay on his Grounds 10 Carts of Lime at a cheaper rate than 20 of Marle, he will be a very great Gainer.

There is an easy way by w^h the Value of Marle can be ascertained, we put 200

Grains into a florentine flask, add a little Water, & saturate it with an Acid, then observing the loss of Weight; if it loses 40 Grains, there are 100 Grains of Calcar^s. Matter in the Marle; the loss of weight w^ch it suffers being always about 40 p^r Cent of the whole, or 42 at the most, & and whatever be the loss of Weight, we can judge of the q^ty of Cal^s. Matter contained in the Marle. I've tried natural Marles, & made Artificial Mixtures to learn to what Nicety a small q^ty of Cal^s. Earth can be judged of, & I find that a 50^th, or even a 100^th part can be estimated by an Exper^t. of this kind.

Another way of ascertaing the q^ty of Cal^s. Matter is by first dissolving it in an Acid, & then precipitating it with an Alkali; but this is too nice a Process for some of those who reckon themselves Chemists.

With this I finish the Acct. of the Cal: Earths; I proceed to consider, by way of Appendix to it, some Compounds, having this Earth for their Basis, combined with Acids, wch deserve to be taken notice of —

The Gypseous Concretions are com- Sect: 64th. monly presented to us in the form of Stony Masses, but are remarkably soft, being easily scraped; they don't effervesce with Acids. as the Cal: Earths do, but when reduced to a Powder & boiled with a Solution of the common fixed Alkali for some time they change it into a Vitriolated Tartar. They are found in the Strata of Clay in sepa- rate Masses, & when pure are of a whitish & diluted milky Colour, & small pieces of them are often transparent or tinged with a reddish Earth. And a particular Species of them called

Gypsum is composed of small Crystaline Grains, wch is sometimes called Alabaster when

it has a considerable degree of hardness &
is capable of receiving some Polish, so it is
cut into Toys imitating those of Marble.

Fibraria, so called by Dr. Hill, is another
Species, wch is found of a fibrous Structure
& composed of oblong Concretions lying
across the Mass, but they don't differ
from the rest, except in the particular
arrangement of the Particles.

A 3d. Species is composed of clear
transparent Plates, & can be easily scraped
with a Knife. In some parts of Russia
these Plates are so large that they answer
the purpose of Glass, & is called Glaceous
Maria, or Muscovy Talk.

A 4th. Appearance, is in the form of
streight oblong Crystals, & then it is known
under the name of Selenites, & does not
ill resemble the Crystals of Salts.

5th. One of the kinds of Spar contains
a large qty of this Earth, it does not

effervesce with Acids, & is distinguished from all other Stones by its extraordinary weight, wch is so great as to give a suspicion of its containing a great q^ty of metallic Matter. It has always a plated Structure, & if broken with a smart blow it shivers into fragments of a rhomboidal figure. It has not that flexibility wch the other kinds of Gypsum have. It is called Marmor Metallorum, from its being the Matrix in wch the Metals are often found. Margraaf discovered yt it was composed of Gypsum combined with a small q^ty of other Earth.

Lastly, it also often occurs in Waters, having a small Degree of Solubility in Water. It always forms into slender filamentous Crystals like hairs.

The nature & Composition of these Substances were first explained by Margraaf, upon boiling it with an equal weight of

alkaline Salt the Alkali attracted the Acid & furnished Air to saturate the Limy Earth w.ch the Gypsum contained, & w.ch was found in the Vessel in the form of a Cal.d Earth.

This Acc.t of their nature enables us to understand several of their qualities, in consequence of w.ch they become useful, when exposed to a gentle heat & afterwards mixed in Water. — It is reduced into a fine powder & put into an Iron Vessel, the bottom of w.ch is made red hot, the Powder gets a float, appears like a fluid, so y.t Waves go thro' it as if fluid, & there is a kind of Ebullition like y.t of boiling Water, this continues till the heat has been raised to a certain degree, afterwards the Powder turns heavier, subsides & loses the appearance of fluidity, then allowing it to cool, & mixing a q.ty of it with Water to the Consistence of Cream, the whole hardens so as to form a Stone

of

of considerable firmness, without the least shrinking, there is manifestly a concretion of the Water & calcined Gypsum with one another, from a degree of heat produced the Mixture becoming sensibly warm about the time they concrete, & this happens in consequence of the Crystalization, & it may be compared to the Crystalization of Salts, wch in a crystalized State contain a qty of Water, & it resembles some of the Crystals of Salts by parting with this Water when it is suddenly heated; the heat takes away its transparency, makes it white, opaque, & renders it more friable, as when I put it upon a hot Iron; if a more violent heat be applied it does not undergo much farther Change if the fuel does not touch it, the Vitriolic Acid adheres too strongly to be readily separated by heat, tho' when it is kept long in a very violent heat it undergoes a fusion; & if the Steams of the

Inflammable Matter unite with it they render it an imperfect Sulphur when it is more easily convertible into Vapour, & by continuing this contact of the fuel we change it into a Cal: Earth.

By a particular management, these Earths afford a kind of Phosphorus, when they are in contact with fuel some time they imbibe Light & retain it for some time.

From the nature of the 2 Substances, of wh. they are composed, we will understand the other Properties they possess.

They are used for casting of Figures, & they answer for making Moulds in wh. the same figures are to be cast, they are taken from the finest figures of Antiquity. This Substance applies itself to the Surface of the figure, & soon after forms a hard Mass, & it can be taken off, & different parts can be applied so as to form an entire Mould, & it is prepared

for use by imbibing a q^ty of Oil w^ch hinders the fresh Matter from adhering to it. It forms Paste for making of Ornaments in Stucco, & about Paris it is much employed in the building of Houses.

The same Author to whom we are indebted for the late Discovery with reg^d. to the Composition of Tartar, has given us another kind of Stone, w^ch on acc^t. of the light he has thrown upon it, deserves to be considered as one of the most curious Objects of Philosophical Chemistry. It is a 3^d. Species of Spar w^ch has been long known in Chem^y & Natural History as being different from the Calcarious & Gypseous Spar, it is called the German fell Spar, fluor Spatosus, &c, as it assists in melting the Ore from Stony Matter. It is always found in Veins, never constituting Strata. It has a close glassy texture, & is more or less transparent. It is often found

Crystalized in the Cavity of the Veins, & always forms Cubic Crystalizations, wch are sometimes Colourless, but more commonly tinged either greenish, yellow, or purple. There are great quanty of it found in Derbyshire, wch on accot of the particular Arrangement of the Crystals & flaws dividing them, gives a very remarkable Appearance when polished. The Specimens of it having these Colours have got Names from some of the Gems to wch they bear an imperfect resemblance. It has a disposition to emit a pale Light when exposed to a certain degree of heat, & it continues to shine till it is heated red hot. These having a Colour lose it while the luminous Vapour flows out, wch is manifestly some subtile Matter expelled by the Heat. They are called Phosphoric Spars, & some of the Gypsum has a quality of the same kind; their Colour can be

discharged by a violent heat. It has a powerful Effect in promoting the fusion of other substances partic^y the Gypseous Spar. We have got but a short acco^t. of M^r. Scheles Exper^ts or rather a very inaccurate Translation at the end of a little Treatise, &c.

By applying an Alkali he found it to be a Compound of Calcar^s. Earth with an Acid. The Alkali when mild decomposed it, but when deprived of Air had not y^e Effect; so like the Acid of Tartar it has a stronger Attraction for pure Calcar^s. Matter than for pure fixed Alkalis, but the Air in the Alkali disposes the Calcar^s. Earth to part with the Acid. He contrived to get this Acid in a separate State by means of the Vitriolic Acid, & he got an Acid different from others, to w^h he has given the Name of the Acid of Spar. Like the Muriatic Acid it requires a good deal of Water to its Condensation, & it also resembles it

in Odour. But while the Muriatic Acid produces a compound with the Cal.^e Earth w.^h is easily melted with Water, this Acid produces a Substance perfectly insoluble, as is the Stone in its entire State. Thus, when we mix a small q.ty of the Acid w.^t some Lime Water it becomes muddy & deposites the Cal.^e Earth, the Acid uniting with the Lime so as to form a Spar or fluor Spatosus.

It has also a power of producing a flinty Substance with Water, this was observed during the Operation by w.^h it was extracted from the Spar. It is (reduced to a powder mixed with the Vitriolic Acid & put into a Retort & applying a gentle heat the Vitriolic Acid attracts the Calcar.^e Earth, & the Acid of the Spar rises in subtile & incondensible Vapours, w.^h fly out at the Mouth of the Retort, & it is necessary to condense these by applying a Receiver w.^t Water at the same time they enter y.^e Water,

ther is a white spongy earthy Matter formed upon the Surface, the q.ty of w.ch increases till the whole Surface is covered, then y.e Communication between the Acid Steams & the Water is cut off, & they begin to flow out again at the Joining, so y.t it is necessary to take off the Vessel & shake the Receiver to break this Cake, then y.e Water absorbing the Acid again more of this Matter is formed, & this takes place all the time of the Distillation. M.r Sheels found the Earthy powder to possess the qualities of the flinty Earth. It is perfectly infusible, & in combination with an Alkali forms a Glassy Compound; this is a curious fact, that a subtile Vapour joining with Water sh.d produce a flinty Earth, & we have no Principles w.ch will explain it. It may be supposed y.t this Matter is from the Glass Vessel, especially as it is found remarkably corroded so it might be a

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part of it dissolved & volatilized by ye Acid wch separated again when the Steams strike the Surface of the Water. But ye ingenious Author thot of this & made an Expt to ascertain this, he took a qty of the Powdered Spar & put it into a Gun barrel & added a qty of the Vitriolic Acid, when he suspended over it a bit of Charcoal wetted with Water, & applying heat to that the Acid shd strike the Surface of the wet Charcoal, & the Steams formd upon its surface ye same kind of Earth, so yt this flinty Powder does not come from the Vessel. Neither could it have been produced in the Acid. I can't suppose yt it wd be combined so strongly as to assume the form of a subtile & condensible Vapour, as there is no Matter less disposed to fluidity or Volatility in its separate State. Therefore this appears to be a new Substance wch did not exist before. Mr Sheele has discovered many other qualities of this Acid, but tho' they

are

are curious they are not so material, among the rest he satisfied himself that the Analysis was compleat; by reproducing it, adding to Quicklime a proper q[t]y of the Acid of Spar he obtained a white Powder with all the qualities of the Original Spar. Such therefore is the Fluor in natural History — And this finishes the list of the Compounds with the Calcarious Earth for their Basis —

We proceed to consider the next heads of Earths, the — Sect: 65.

Clays.

This is among the most abundant in Nature, constituting numerous Strata in the bowels of the Earth. Hence it is often employed as a Manure for improving the Soil, a Soil consisting of pure Sand being the better of Clay; & when it is used in this man-

ner it is called Marle, but this Name is more properly applied to Clay-Earths which contain a qty of Calcary Matter, & wh is a useful addition to any Soil whatever, even where there is plenty of Clay, provided it has not received Calcar: Earth before.

It is a Substance of wh the Particles are very fine & smooth between the fingers, a Mass of it has the same Smoothness of Surface as a Mass of hard Soap. In its natural State it is always moist, & when dried the parts cohere strongly together, & in this State it has a strong disposition to imbibe Water. By applying a Mass of it to the Tongue, by the sudden Absorption of the Water, it firmly adheres to the Surface of the tongue. When it is mixed with a large Proportion of Water & kneaded a little it becomes a remarkably ductile adhesive Mass, wh is not easily fusible in more Water, & to render it thin it requires a great deal of Work; hence it is employed

as a means of confining Water in large Works, as in making Canals & Dykes, where the Soil must contain Clay or a qty be bro.t by the Water & deposited at the bottom, wc. render the Dyke capable of containing Water. Hence we understand the bad Effects arising from Cattle being allowed to tread much on Clay Grounds when they are wet, as the Clay is reduced to such an adhesive Mass yt it does not admit the Roots of ye Vegetables to penetrate the Soil, nor of Water to enter to the Roots. These are the obvious qualities of this Earth.

The Variety is very considerable, with respect to the fineness & softness of the Particles, some melting with the Saliva in the Mouth, others feeling more or less gritty between the teeth. Some of it is of a whitish Colour, some of a grey, bluish, or reddish. It is more or less diffusible in Water, some of it becoming quite pulpy in it. Some of it resists the most violent fire wt-out melting, others melt into a spongy or

or Vitrified Mass. Some produces an Effervesce with Acids, others do not _ Some are called Boles, wch consist of fine soft Particles, & noted for a particular Colour, reddish, bluish or yellow; These were formerly in high Estimation for their Medicinal qualities, & were brot. from the most distant parts of ye World; & as it was easy to imitate these, it was necessary to stamp them with Seals as a Proof of their being genuine, so were called Terra Sigillatæ. But we genly find a large admixture of Sand, & in general all the Clays feeling gritty, derive this quality from the sandy, calcarious, or other Particles. An easy way to satisfy ourselves of this, & to obtain the Clay Earth in a purer State is to mix it with Water to the Consistence of Milk or Cream, when the Sand will settle to the bottom first, & then we can pour off the muddy Water containing the Clay. This is called Elutriation in Chemy. The Variety of Colour depends upon Iron in

most Cases, w.ᶜ can be extracted from a great Variety, especially those w.ᶜ burn red in the fire. Some Mixtures of this kind are so rich in Iron that they are melted & the Iron extracted with profit. In others the Colour is from an Inflam.ˡᵉ Matter, & these are distinguished by burning White when exposed to heat in a proper manner.

From this view of the Variety produced among y.ᵉ Clay Earths by these admixtures, you'll understand whence arises the Variety in their qualities, why some effervesce with Acids from the presence of Calcar.ˢ Matter, why most melt when exposed to a violent heat, as we find y.ᵉ an addition of metallic Substances to Clay disposes it to melt, particˡʸ that the Calces of Iron have this Effect.

We shall consider y.ᵉ kind of Clay w.ᶜ is reckoned the purest, & is employed in the Manufacture of Tobacco Pipes, it is genˡʸ of a whitish grey Colour, but it is a necessary quality,

that it may acquire a fine white Colour when exposed to a certain degree of heat. It contains but a small qty of sandy Matter, & is smooth & unctuous between the fingers. It does not produce any Effervescence with Acids, it forms a paste ductile in Water, & when dried & burnt it becomes as compact & hard as flint, at ye same time no degree of heat yet tried is capable (of bringing this Clay into perfect fusion, it only softens it, makes the parts unite together & to undergo some approach to fusion. The Tobacco Pipes are burnt with only a moderate heat, & by increasing the heat they can be made much harder; if any Smoake is admitted to it it is liable to lose its whiteness, & the common way of burning ware is by putting it into Earthen Vessels called Seawers or Safeguards; if the flame be freely admitted to them the Ware wd. turn out black, the Clay Earth showing an Attraction for the Pr. of Inflamy of these Vapours.

From the Properties of Clay, w.ch we've mentioned, it becomes useful for forming some Chemical Vessels, but it forms them very compact & not fit for bearing sudden Changes of heat & Cold; we therefore add Sand, the Mineral Substance called black Lead or Talk. It is not easy to say in what manner these additions produce their Effect, but when they are added in certain q.ty the Vessels endure these Alterations much better. I referred to some Papers publish'ed by M.r Pott of Berlin upon this subject, who has particly considered it & made a great n.o of Exper.ts upon it. These were the most of the particulars we were acquainted with with respect to the Clays till some time ago when Pott & Margraaf enlarged our knowledge;

M.r Pott first observed in his Lithogiagnosia when he was exam.g some Earths & Stones mixing them together in diff.t Proportions & with Alkaline Salts & exposing them to a

violent degree of heat he obtained a qty of Alum from a Mixture of Clay & the Vitriolic Acid. The Nature of Alum was not understood: it was known to contain an Earthy Substance with the Acid, but they supposed it to be the Calcar:^s Earth. Pott gave reasons to suspect y^t. it was the Clay Earth, & Margraaf has ascertained this point more clearly. He employed himself with a Sett of Exper^ts. upon Alum; he first separated the Earth by dissolving the Alum in Water, & adding some fixed Alkali w^ch attracts the Vitriolic Acid & precipitates the Earth. He attempted to combine this Earth with the Vitriolic Acid & did the same with Clay & obtained a Comp^d. Liquor or Solution by distillation exactly the same from both, but evaporating these for obtaing alum he did not succeed. The Liq^r formed a thick gelatinous Mass, w^ch exposed to the Air attracted humidity but did not give Crystals,

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& examining the Manufacture of Alum, he found that it was necessary to add a certain q^ty of Alkali to the Solution; a little of this dropt in occasions a turbidness & deposition of Particles like Sands, w^ch were small Crystals of Alum, & these taken out & dissolved in Water give large Crystals; or they used putrid Urine contain^g Vol: Alk: w^ch likewise answers y^e purpose; therefore the aluminous Earth is capable of uniting with the Vitriolic Acid, except in one particular way, i, e, with an over Proportion of it; & to obtain a perfect Alum it is necessary to add a little Alkali to take away this over Proportion of Acid; & from multiplying his Exper^ts upon the Clay he found that tho' some of them were very pure there are more w^ch consist entirely of Clay Earth; some affording the finest were found to contain a small q^ty of flinty matter in subtile Powder, the most of them amounted to more than the half of the Weight of Clay. These

Experim^{ts} have demonstrated the nature of Alum, y^t it is a Comp^d. Clay Earth with the Vitriolic Acid. Allum deserves a little of your attention on acc^t. of its use in Medicine & the Arts. Its appearance & obvious qualities are sufficiently known. It comes to the Market in large Crystalized Masses resembling Borax in its external Appearance. It undergoes the watery fusion & continues to boil & bubble for a while, during w^{ch} the Water is dissipated, & the Vitriolic Acid & aluminous Earth remain behind in the form of a white spongy Mass w^{ch} is called <u>Burnt Alum</u>, <u>Alumen Ustum</u>, & no degree of heat can bring this Mass into fusion, the Vitriolic Acid may be expelled, but then the Matter remaining never shews any disposition to melt. It has a certain degree of Solubility in Water, it dissolves much more copiously & quickly in warm water, the Liquor has a sweetish sour astringent taste, somewhat

resembling that of the Acid; only the Sensation of the Sweetness & Astringency is more remarkable than y^t. of the pure Acid. It produces the same Effect upon some of the Vegetable Colours, changing the Colour of Litmus to a red, but it produces no sensible alteration upon an Infusion of Roses, w^ch is not so sensible with resp^d to the Acids, there is rather a disposition towards the greenish tinge; w^ch several of the Earthy Substances produce with the Syrup of Violets & Tincture of Roses. It is readily decomposed not only by the fixed & Vol. Alk. but even by y^e Absorbent Earths, as Chalk, w^ch thrown into a Solution of Alum effervesces with it & precipitates the Earth of Alum, not pure, because y^e Chalk forms a Selenite w^ch falls to the bottom. But when Magnesia is thrown in the same thing happens & the Earth of Alum is precipitated pure. From the Effervescence we perceive that the Earth of Alum has no disposition to unite

with fixed Air; & by applying an Acid to it we find y.t it contains only a small q.ty of y.t Sort of Air. The Earth thus obtained proves a pure argelaceous Earth, purer than any Clay, & having the qualities of Clay in greater perfection, forming a tough ductile Paste in Water, baking to a great degree of hardness & resisting the utmost Violence of Fire without the least disposition to soften.

With reg.d to its Origin, it is said to be found in small q.ty in some Springs, sometimes it occurs crystalized from such Waters in the form of small filamentous Crystals, but these Examples are rare; & all in the Market is got from laminated stony Matter w.h bears some resemblance to Slate but is softer, the Colour is gen.ly grey & black, & it is composed of Clay with Sulphur & other Inflam.le Matters, they are dug up & exposed to the Air when they crumble down, become hot, take fire, & burn slowly for a consid.le time.

The remains are steeped in Water, wch afford an aluminous Liquor, having a disposition to Crystalize by the Addition of fixed Alk: Beds are made in the Neighbourhood of the house in wch the Evaporation is carried on, the bottom of these is made so close that the Water can't easily penetrate it, & it has a slight descent into the Cistern in the house, so that the Rain falling on this Matter, or Water put on it, is conveyed to this Cistern, & from thence pumpt up into the boiling house, where it is boiled down to a proper degree, the proper ~~degree~~ addition being made of fixed Alkali from the Ashes of Vegetables, or from Kelp or putrid Urine; the Evaporation being carried to a certain degree the Liquor Crystalizes into small transparent regular Crystals. This at first contains a small qty of Iron or Pyrites wch is dissolved at the same time, but by redissolving these again & repeating the Crystalization they become

sufficiently pure by the first Operation, then they are compacted into more solid Masses by the Operation called Racking. They are made to undergo the Watery fusion, & suddenly poured into a large Vessel, where the fluid concretes into one Mass, wh is divided into several flaws & cracks, & is called Rock Alum. It is chiefly used in the Art of dying, & in the Preparation of Leather & Parchment, & is useful in Medicine on many Occasions.

The next Class is the

Flinty Earths.

Their distinguishing Character is extreme Hardness, they scratch Glass & strike fire with the hardest Steel, a part of the Steel is torn off with such Violence as to be heated red hot, & flying thro' the Air it is blown into the State of Inflamn.

This flinty matter is also called Crystaline

& Filragent, occurring in the form of regular Crystals. & it is the principal Ingredient in the best kinds of Glass. It is supposed to be purest when transparent & colourless; & when it has only a whitish or milky transparency it's called Quartz, but it often occurs in an impure State when the Appearance is various.

The Flinty Earth when transparent & Colourless, is called Crystal, when it has a whitish Colour like Milk & Water it is called Quartz, & when it has a horny appearance it is called Flint Silex. These are the Shapes in wh it is supposed to be perfect, but it often occurs impure, & the appearance is various. Sect. 66th.

1st. It is found constituting Strata in the Sand, Gravel, &c. Some Sands are perfectly white & found to consist of Grains of pure Quartz. Gravel is much of the same nature as Sand, & forms considerable Strata

mixed with Sand. It consists of this Matter in large Grains & Masses, & is seldom so pure but has an admixture of other Matters. Pebbles are some of these Gravel Stones & owe their beauty to the great purity of their Materials & the manner in wh. they have been found, the external Surface is rough & unpromising, but when broke they have a different appearance, shewing an exceedingly smooth Surface wt. Colours & Veins from an admixture of other Earth with the flinty. There is always a Central Piece, around wh. is a no. of Layers diversified, in all the whitish or milky Pebbles these Layers are less transparent. This is particularly the Case with regd. to the Stones of this kind called Agates. In others there is a no. of diffr. Colours, two or more in the Composition of a Layer, wh. gives a greater Variety to the Appearance of the Stone. Dr. Hill has endeavoured to ar-

range

range these Stones, but the Variety among them is so great that there is no end in the Division,

Some of them, appearing like Pebbles, are Colourless & transparent within, & are called Pebble Crystals. In others the Colouring Matter is diffused thro' the whole of the Stone, & are sometimes of a pale red like Flesh, as the Cornelian, &c. Some have Ramifications of a dark Coloured Matter, resembling Moss or Tea Plants, wc. has been occasioned by an opaque Matter insinuated into Cracks in the Stone & branched out into figures resembling these Vegetables, as in the Mocha Stone.

The Free Stone employed in building also chiefly consists of this flinty Earth, it is plainly composed of Sand cemented together by an Operation of nature, as appears from the manner in wc. the different Layers separate, the Surface of which

is waved like the Sand on ye Sea Shore, so we can't doubt that this waving has been produced by the action of the Water, & we meet with the Relicts of the Productions of the Sea, as Madripores, &c. These Stones are of various hardness, in some the Particles have little more Cohesion than Sand, in others the Grains are so closely compacted as to look like a solid flint, & they can be wrought like free Stone, wch requires to be of a moderate degree of hardness, so as to be cut without much difficulty, & at the same time it is capable of bearing exposure to the Air without being easily decayed. In England, &c. there are Strata of Sand & Gravel cemented together; and the Pudding Stone is composed of a whitish Sand intermixed with Pebbles, so compact that it receives a fine Polish & looks like the Skin of a spotted Animal,

When I thus mention free Stone or

gritty Stone, (as composed in gen.l of flinty Particles, I must also take notice of the Bath or Portland Stone, as an Exception, w.ch is composed of a Sand of a Calcarious nature, as I explained before,

The flinty Earth is the principal Ingredient in the Garnet, & in the more Compound Rock called Whin, w.ch is a coarser kind of Garnet, containing a very large q.ty of Iron. Garnet appears to be formed like Free Stone, & a great many of the grains composing it are of the flinty kind.

Therefore upon y.e whole there are not many Stony or Rocky Strata, but what contain more or less of this flinty Earth.

Besides, it is found in Veins, filling up perpendicular fissures, & is called Quartz, it is of the Colour of Milk & Water, occur.g sometimes more transparent & sometimes more white, & in it there are innumerable flaws, so the broken surface is always very

rough & uneven; sometimes it occurs of a foliated Structure like Spar & breaks into rhomboidail pieces, & is a mixture of Spar & Quartz. The

Silex or Gun Flint is found intermixed with Strata of other Matter, it is sometimes found in Veins, but the greatest qty of it is found in the Strata of Chalk, with wch it is intermixed in very various ways, often filling up perpendicular Rents; & besides it is interspersed with Nodules connected together in a horizontal direction; the form of these is quite irregular, sometimes roundish, sometimes oblong, in such a manner as can't be described.

Another appearance often occurs in the Strata of Lime Stone, & is called Chirt, it is met with like flint in Chalk, thro' the Lime Stone, & a part of the Lime Stone seems to be converted into flinty Matter by some Operation of nature, & we find ye Relicts

of marine Productions in the middle of it, with wch the Lime Stones abound. Some of these Appearances also occur in the Masses of Flint among Chalk, wch seems to have been penetrated by some matter wch has produced this Change upon it.

But among the most curious forms in wch the flinty Earths appear, are the Crystals. These are always found in the Cavities of Veins where the Quartz occurs. They are either Columns of 6 Sides terminating by a Pyramid, or they are found separated from the Surface of the Cavity, & pyramidal at both ends. But more comly there is not any particular Column but merely a Pyramid, still consisting of 6 Sides, & thick set by one another; so with regard to the Columns or Sprig Crystals, these have not a regular Pyramid, but the Sides of the Column converge together from the Sides towards the top, so that the top is cut off by

an oblique plane; & we find in these all the Irregularities w^ch occur in the Crystals of Salts.

Some of the Pebbles are hollow, & when broke their Cavities are found lined with this sort of Crystalization. These Crystals also vary in their Colour, some are transparent & Colourless, as the German Crystals. Many have a dark Opacity w^ch makes them appear quite black till they are broke in many Pieces, when they appear transparent, & in many Cases the Colour can be put away by heat, by exposing it to a fire, or by surrounding it with Oil, but if the heat is too great it sometimes occasions Cracks & flaws.

They pass for Gems, their hardness is nearly equal to that of Gems, & their Colour is fully equal, they have their beauty, receive a fine Polish, & wear sufficiently well. Some have a beautiful purple Colour & pass for the Amethyst; some are of a yellow Colour, w^ch pass for the Topaz, &c.

To the same Head we may with propriety refer the Gems wc are found either in the State of Crystals or Pebbles & seem to be composed of flinty matter, appearing in a much purer State than ordinary, or perhaps in Consequence of its being improved by the admixture of some other Matter. The Colour for wc many of them have been admired has been imputed to metallic Substances, & Chemists had good reason to suppose this, as they found yt the Calces of Metals can be made to ting Glass with Colours resembling these of Gems, but we find yt the Colour can be expelled by a gentle heat, & this is attended with a luminous Vapour around the Stone, so yt it depends upon a Matter more subtle than ye grosser parts of the Metals, as is the Case with respect to the Colour of the Amethyst.

The other form in wc it appears is as constituting Petrifactions. The finer Masses

of Animal & Vegetable Matter so penetrated as to become flinty, still retaining somewhat of their original form. We have many curious Examples of this in different parts of the World. Here are Specimens of Shells changed into flint; & pieces of Cockle & Periwinkles, wh. strike fire with Steel. But what is still more surprizing, are some Examples of petrified Wood, where some of the constituent parts still remain, wh. we wd. little expect to find remaining as the Inflamle. Matter wh. gives it a Colour, & upon exposing it to heat it still appears luminous. In another piece the Inflamle. Matter is gone, but we can see all the little Air holes or Extremities of the Air Vessels abounding in the Wood, yet the whole is a Mass of hard Flint.

Such are therefore the Varieties in wh. the flinty Earths are presented to us by Nature.

With regard to the Chemical qualities, the

the most intense Heat has never brot. it into a State of fluidity. Some of the Gems do not undergo any Change from a violent heat, but in general it loses its transparency & is traversed by innumerable flaws wc. render it more easily broken in pieces.

The best known & most useful quality of this kind of Earth is the disposition it has to yield Glass with alkaline Salts, wn. melted in a violent Heat, wc. is one of the most elegant & useful Discoveries wc. Chemy has afforded, Glass being useful on acct. of its transparency, the forms it can be made to assume, &c. Besides these Ingredients, others may be made use of, as Arsenic, wc. promotes the fusion of the Ingredients, & destroys some Matters wc. are mixed with & diminish the transparency of the Glass. Lead is comly employed in our Drinking Glasses, it increases the Tenuity of fusion, a greater qty of the

Flinty Earth with a greater Proportion of Alkali being used, & a little Magnesia w^{ch} is of a purplish Colour to destroy the greenish taint, but the chief Ingredients are the flint & alkaline Salt, w^{ch} must bear a certain proportion to one another, according to the nature of the flint. In general if there is too little alkaline Salt it does not become perfectly transparent but retains a little of the milky appearance of the flinty Earth. If too much Alkali is used the Glass is liable to be affected with Acids & by Water, & it even attracts the humidity of the Air & is deliquescent. When the flinty Matter is thus dissolved in Water it forms the Liquor into Silicum, from w^{ch} the flinty Earth can easily be separated by adding an Acid. Newman observes that a Vol: Alk: added will occasion the Precipitation, & thinks it extraordinary y^{t} it sh^{d}. be precipitated by an Acid or Alkali;

but it acts by affording fixed Air to the fixed Alkali, by neutralizing it & dispo-sing it to part with the flinty Matter. Besides some of the neutral Salts contain the Alkali in such a State as to be separable from the Acids, as Nitre, wh is often em-ployed in making the flinty Glass, as the Acid of the Nitre helps to calcine the Lead more perfectly, & to reduce it to the proper State of forming transparent Glass, while the Alkali unites with the flinty Earth. Borax also promotes the tenuity of the fusion in making very transparent Glass, & the Alkali is here uni-ted with one of the weakest Acids, it retains the most fusible of its properties, & acts much as if pure, while the sedative Salt melts along with the other Ingredients with-out disturbing the transparency of the Glass — For obtaining a pure & fine Glass the Artists have employed

a Mixture of Alkali Nitre & Borax, with the Calx of Lead, & when they use the fine flinty Matter it turns out a bright & transparent Glass, in so much that the Diamond is imitated in part of the Lustre & transparency; & the coloured Gems are imitated by adding a small quantity of the metallic Calces, w.ch give diff.t Colours by using them either separately or mixed in different Proportions, whereby the Colours of the natural Gems can be exactly imitated, they are improperly called Pastes in this Country — This is a gen.l notion of the nature & use of the flinty Earths.

Fusible Earths.

I don't mean that this Title comprehends the only fusible Earths, several other qualities are to be attended to, Sect: 67.

as also the absence of some qualities, but they possess this quality in the most eminent degree. The Character w^ch^ may be given them is this, they bear a great resemblance to the flinty Concretions, they are (?) very hard Substances, they don't effervesce with Acids, but they are not so hard as the flints, they do not strike fire with Steel, nor scratch Glass, they shew no great degree of fusibility, altho' they possess this quality in the highest degree of any of the Earthy Substances. When reduced to fine Powder & mixed with any of the Acids they do not emit volatile acid Steams, nor are they by means of a Solution of alkaline Salts changed to a Calcarious Earth.

I think it is doubtful whether y^e^ Earthy or Stony Substances, I call the fusible, have a particular Substance for their basis, or are only a mixture of others very

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perfectly united together. I am of opinion that they are mixed, but till we know more of their particular nature I must consider them as a distinct Class.

The natural Stones, w^ch seem to require a separate Consideration under this title, are of 5 kinds.

It is most pure in what is called Flus by the Germans, or Fluores. They are like the more transparent quartz, they are com^ly tinged with different Colours & have their Names from the Gems, as Pseudo Smaragdus, &c. They are distinguished by their great degree of fusibility, so that they pervade the crucible in w^ch they are melted. We find this sort of Earth in the Rhombic Quartz, w^ch are composed of flinty matter combined with this in different Proportions, it is also called Fell Spat. It is found in the Garnets, it is composed of angular Grains, w^ch in most of

the Garnets are so closely compacted as to form a hard Stone capable of receiving a fine polish; it also occurs in Veins, it is a Stone less transparent than Quartz, having comm^ly a reddish tinge or flesh Colour, it appears to have a plated Structure, & has a disposition to break into rhomboidal fragments. The first Effect of heat is to render it more brittle; if it is increased to a strong degree the Stone melts or becomes pasty, & at the same time the rich Colour comm^ly goes off, & it forms a Semi vitrified Mass of very great Whiteness, on this acco^t it is one of the best Ingredients in Porcelain. This is all we know at present of it. Some Gentlemen in Sweden have made further Discoveries, & have proved y^t it contains different Earths united together; but these Exper^ts have not yet come to our knowledge.

Another kind of Stony Matter, containing this Earth is the Garnet, a transparent

a transparent Stone of a rich red Colour like Crimson, many of them are of such transparency as to be reckoned among the Gems, but the greatest No is divided by flaws & mixed wh. a coarser Matter, so have not this Colour, but when examined in small Particles they appear crystallized into somewhat of an angular form. By Chemical Analysis it is found to contain some Iron, to wh is imputed its red Colour, some of em hold a qty of Tin; but there are some Specimens wh contain neither, & these have less Colour, or are of a pale yellowish Colour. It is found in separate Grains in Nodules in Rock Strata wh are chiefly composed of Talk. There is a considble Tract of Hills in the north of Scotland where the little Nodules of Garnet are contained.

Another fossil wh has this Earth for its Basis, is called Coral or Cockel. It is a Composition of Rocky Stones in separate Grains or Masses & crystalized into Columnar Stones, when they are of a blackish Colour they are called Jasper.

& are sometimes shaded green. It abounds in the Composition of the Stones used for beautifying our Streets, wc. are full of oblong Crystalizations of a shining black Colour. When exposed to heat it easily melts into black Glass.

The last matter in wc. this Earth is found, is the Substance called Zeolite, wc. was first examined & characterized by Cronstad in Sweden. It occurrs in Nodules in rocky Strata, & its outside resembles the Pebbles, when broken they often shew a radiated Structure, the Parts shooting into Crystalizations from the Centre to the Circumference of a Sphere, sometimes when broken they are found hollow, & beset within with Crystalizations — Its Chemical qualities are to melt with heat with remarkable fusibility, the most kinds swell in the fire as Salts or Borax does in their Watery fusion; upon increasing the heat it becomes more perfectly fluid & assumes a degree of bright-

-ness like pure Glass, & bears a great resemblance to the Effects of heat upon Borax. Aqua fortis perhaps readily dissolves it, the Liquor becomes gelatinous, some Matter being contained in the Zeolite, wch is not dissolved in the Acid. This is observed by Cronstadt. But further a Gentleman in this place has found in ye Zeolite an alkaline & aluminous, he found that part of it was converted into a neutral Salt, & he could precipitate from the Acid a qty of aluminous Earth, the gelatinous Matter proceeding from a flinty Subsce wch enters into its Composition.

The next & last Class comprehends the

Flexible Earths.

These Earths & Stony Concretions, when pure, are flexible, they don't Effervesce with Acids, they don't imbibe Water like the Clays, nor are they so hard as the flinty, in an extremely violent heat they shew a degree of fusibility.

They are divided by Cronstadt into the Micaceous & asbestine, or into the Talks & asbestos,

The Talks are foliaceous Stones, slippery between the fingers, sometimes colourless & transparent, as the proper Muscovy Talk. It has a great transparency, flexibility & elasticity & is divisible into incomparably thin plates, but more com^y it is coloured, sometimes of a dark dusty colour, & the plates are seldom so small or so much in a plane but waved, sometimes it has a greenish hue, sometimes a yellowish brightness resembling y^t of Gold, & these colours have imposed upon persons & made them imagine they had found Gold or Silver tho' y^e Talk does not contain the smallest particle of either, the yellow Colour is from Iron, & the Silvery appearance from the particular disposition of their plates, for when they are transparent the plates are a little separated; by heat they acquire y^e same Silvery colour; It is sometimes found forming a powdery Subs^ce consisting of minute

Scales, w.ᶜʰ are slippery & adhesive to y.ᵉ fingers, giving them a Colour like that of Metals. & in such Specimens the Earth is mixed with a large Proportion of Metallic Substances. Sometimes it occurs of a black Colour with a shining appearance resembling polished Steel, this abounds w.ᵗʰ Iron; & has not the flexibility of the Earth in its pure State.

The Talk abounds plentifully in the Composition of many Rocky Strata; in the Garnet, & such others as are flexible, & in Rocks w.ᶜʰ contain Garnets, in the Stone called Lapis Olaris, w.ᶜʰ is composed of the Steatites mixed with Talk, & it has a q.ᵗʸ of Magnesia Earth in its Composition; it is useful for Kitchen Utensils for standing the fire well. There is also a considerable Proportion of white Talk in the Composition of Clays & of Gravel, w.ᶜʰ is all from the Rubbish of some Rocky Masses in w.ᶜʰ Talk is originally formed.

The Asbestos & Amianthus differ in their Structure from y.ᵉ Talk chiefly in the flexibility

of their Fibres, & the closeness & Looseness of their Texture. These reckoned the most pure & perfect are these w.ch may be teazed out like Cotton; & can be made into a Web, w.ch suffers no harm in the fire. Here I shew you a piece taken out of an antient Urn. It was used for wrapping up & preserving separate the Ashes of the bodies w.ch were burnt. Some have attempted to make a sort of incombustible Paper of it, but we can't contrive any gelatinous Matter for uniting it w.ch will withstand y.e fire.

Besides the Asbestos, properly so called, there is a fossil of the same nature, formed into Membranes like Leather, or into Masses like flesh, or cork, & have the names of Mountain Leather, Mountain flesh, & Mountain Cork.

The Asbestos varies much in point of fineness of the fibres & flexibility. In Scotland we've some specimens with some degree of flexility, but we have it in a State with little or none of this quality, in some the fibres are

-one & parallel to one another, & when teazed out are like Silk or Cotton, in others the fibres are so compact as to form a hard Stone, but even these hard Stones when long exposed to the Weather become soft like Wax.

Such are the principal Specimens & Varieties of the Earthy Substances. But before we dismiss this Subject you'll expect to hear some mention made of the

Gems.

The Title does not contain any Class of Stones w^ch agree in consisting of any particular Earthy Matter, but any Stone having a Colour, Brightness & Smoothness, w^ch please peoples' fancies or taste, is so called.

They may be divided into the Precious Stones & Gems, the Marbles, Jaspers, Porphery, Garnet & Pudding Stone. Of the Gems some are pellucid & others Semipellucid.

The Marbles are Calcarious Earths & may be used as such for Lime Water. Some of them are Valued in conseq^ce^ of their being of an uniform Colour, as the white & black Marbles, but the greatest number are variegated, w^ch^ depends upon 2 Circumstances, either upon the Reliques of Shells appearing in the Marble, giving it a diversity of Colour, or upon the Calcarious Stone having been shivered into pieces & the Interstices filled up with other Matter.

The Jaspers are applied 2 ways, the Artists make one Application of them, & the Naturalists another. The first apply this Name to any hard Stone capable of receiving a fine polish, & w^ch^ is diversified with various Colours brighter than those of the Marbles, & w^ch^ at the same time contain a harder Matter, often a q^ty^ of flint intermixed. It is in reality a Marble, tho' a q^ty^ of flinty Matter is here & there intermixed as occurs in all

Calcarious Stones, only the Colours are much lighter, with a large admixture of red yellow & white.

In Natural History the term Jasper is applied to flinty Stones, wch are coloured wt Iron, & the most noted of this kind is of a rich deep green Colour with red Spots, as the Heleotropium, in which the whole Colour proceeds from Iron. There are a great many other Stones of this kind, most of em are of a reddish Colour, as the Lapis Lazuli, wch Margraaf shews to have been tinctured with Iron & not Copper.

The Porphery resembles Marble, but is harder, it is of a Chocolate Colour, & with white Spots intermixed, there are many Specimens of it in Italy, probably brought over from Egypt.

The Garnet has the felt Spato or rhombic Quartz for its Basis, with a qty of Talk so united as to form a hard Stone receiving

a

fine Polish, & is valued on acc^t. of the Variety in the Reflexion of Light it gives, & for the different Colours of the Felt Spar.

The Pudding Stone, consists of Sand & Pebbles cemented together, forming a hard Substance w^ch receives a fine Polish, & w^t. Spots like those on the Skins of Spotted Animals.

These considered as Gems, are the Pebbles, w^ch are Semi Pellucid, as the Agate, Onyx, Chalcedony, Cornelian & Mocho Stone.

The Agate has a whitish or milky Appearance, with a more transparent flinty Substance & the milky appearance is diffused in Clouds. In the Onyx this Substance is arranged in parallel Layers. In the Chalcedony there is a whiteness in an unequal manner. In the Cornelian there is a reddish tinge resembling the Colour of flesh. And the Mocho Stone is an Agate with Ramifications of a brown metallic Matter, spreading like the branches of a Tree.

The Pellucid Gems comprehend ye flinty Crystals, Bristol Stone, German Stone, &c. wch are transparent & very bright. The Garnet of a rich Crimson Colour the Amethyst tinged of a beautiful purple, the Topaz yellow; the Sapphire of a fine blue; the Emeral Green.

The Diamond is the most valuable, & at the same time the most remarkable by some late discoveries with regard to its Chemical qualities. Its great hardness is far beyond that of any other stony Substance, & this has inclined us to suppose yt it is composed of a more pure Earthy Substance. But it is not a pure Earthy Substance, it is altered & improved by some addition of a subtile Principle wch renders the whole a volatile Mass, for late Experts. shew it to be very far from being a very fixed Substance, so that it does not agree with the other Earthy Substances in general; when exposed

to no very excessive heat, it evaporates with a luminous vapour or manifest flame, & other Circumstances of the Exp.t have shewn that it undergoes actually a sort of Inflamn.; for unless the Air be admitted it does not undergo any Change; when put into a close Vessel with powdered Charcoal; it withstands any heat without ye least Change: so it is only when it is exposed to the Air & heat at the same time yt it is disposed to evaporate & burn away, till only a very small qty remains behind. Therefore the nature of it is very singular & well worthy of further Investigation.

Now we've done with the History of ye Earthy substances, except the mentioning of the Effects of violent heat upon them, & of mixing them with one another & with some other bodies under the action of a violent heat.

This deserves our attention, as from it has arisen the elegant

Art of making Porcelain or the finest kinds of Pottery.

Mr. Pott of Berlin has made a Sect: variety of Exper.ts upon the different 6th. kinds of Earth, into wc. he was led by a desire of discovering the Composition of the true Porcelain, & wc. he published in his Lithogeognosia. They are so diversified that I can give only a genl. view of them. He mixed them with Salts, with some of the metallic Calces & with one another, & exposed them to the most violent heat he could command by means of fuel in a furnace constructed for that purpose. The genl. result with regard to the Earths of the purer kinds, is this, they all turned out difficult of fusion or rather perfectly infusible. But later Exper.ts have shewn that several of the purer Earths are ~~in~~ capable of a very perfect fusion, & his furnace seems not to

have been constructed upon the best Principles, the Vent was too narrow. Most of the Talky Class & all the Class called fusible, tho' requiring a very violent heat, as fusible by themselves, Gypsum is also fusible by means of the saline matter it contains.

But tho' he imagines them to be infusible in their separate State; he found them all fusible by means of proper additions; the most powerful Substance for this purpose was fixed Alkali, Borax, & the Calces of some of the Metals; a certain q^{ty} of the fixed Alkali, added to the flinty Earth in Powder bro^t. it into a State of fusion, & a little more added makes it very transparent. The absorbent Earths, Gypsum, Stealites, & Clay are not easily bro^t. into fusion by means of Borax, the Calces of the Metals, of Iron, & more especially of Lead, proved a Solvent of all the Earthy Substances, except the absorbent, tho' the Lead in its metallic form has not the

power of dissolving the Earthy Bodies. Upon examining the Earths he found y.t the Calcarious & absorbent Earths proved a means of bringing the flinty & argelaceous Earths into fusion, the Calcarious Earths or Gypsum & still more readily the fluor Spatosus, w.ch contains the Calcar.s Earth with Spar, prove powerful in bringing these parts into fusion, & mixtures of these in certain proportions have still more power & are capable of melting large Masses of other Mattter. We find some of these so fusible as to dissolve the bottom of the Crucible.

The Knowledge of these Particulars is useful in extracting the Metals from their Ores, some of them being so intermixed with a q.ty of Earthy & stony substances that it is difficult to separate them. Elutriation is used for this purpose, the whole Matter is pounded & set in motion in Water to set the lighter parts afloat, and the

metallic remains behind; but in some Cases they are so blended y^t they can't be separated without great loss, the only expedient is to melt the whole when the metallic Matters settle to the bottom, & the Earthy bodies float above, forming a glassy fluid incapable of mixing with the Metals in their Metallic State. But many of the Earthy Matters thus blended can hardly be melted. And the Metallurgists made a Practice of mixing Earthy & Stony Substances together, bro^t from distant Places, to obtain Compounds of easy fusibility. These Compounds being discovered, Mr. Pott explained the nature of them, that the Materials are always of the Calcario us kind, & these when added to the flinty matter or Quartz the attendant of Ores, greatly promote their fusibility.

Mr. Pott has pointed out these advantages resulting from his Experim^ts but he is silent upon

the Subject of Porcelain, the only object wh (led him to all these). It is alledged y.t he discovered some Secrets in this way w.h he chose to keep to himself & make profit of, & all the Information we have on this Subject is from other quarters.

The Porcelain bro.t from China & Japan has been long admired on Acc.t of its beauty, but it was more admired than any hopes were formed of our being able to imitate it. We attempted some w.h had a consid.le share of Beauty, but inferior to the true Porcelain. Clay is the foundation of these Arts on acc.t of its plastic Nature & the degree of hardness & firmness w.h it can be made to assume, but it forms Vessels without any beauty, which never burn very white, but are apt to break & divide when suddenly heated. The addition found necessary to give them beauty, was a large proportion of flinty matter, & this is the Composition of the Stone Ware, & to this is owing their Strength

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Strength, Durability, & a consid.ble share of White-
ness. The Manufacturers discover'd an easy
way of giving it a sort of Glaze to render it
very durable, this was put upon it by throw-
ing into the furnace, when the heat was raised
to the highest degree, a q.ty of common Salt,
the Steams of w.ch diffusing themselves thro'
the whole Cavity, penetrates all the Cases
in w.ch the Ware is contained, & applying
themselves to the Surface of the Ware, brings
a small Portion of it into a State of fu-
sion, & so produces a glazing upon the out-
side; but still there is a n.o of little Pits
left not covered by the Matter, & in w.ch may
lodge dirt & foulness w.ch can't be taken
out again. Of late, this Sort of Ware has
been improved in some degree by a Sort of
glazing, w.ch takes away all these inequalities
tho' it does not give them a Colour to be com-
pared with that of Porcelain. It is a Compo-
sition of Materials w.ch serve to make Glass,

mixed up into a thin fluide of the Con-
sistence of Cream, & laid upon the Surface
of the Ware, & this by means of a new heat
is diffused over the Ware, & gives it always
more or less of a greenish or yellow Colour,
wch is not disagreable, as it is diffused u-
niformly over the Surface, tho' the other
Method had the advantage of one fire set-
ving both to melt the glazing & bake
the Ware. But
The more perfect Ware of this kind is
still far inferior to the China & Japan
Porcelain with respect to its dilute & du-
rable Glazing, & the Lively Colours it is ca-
pable of receiving on accot. of the whiteness of
its ground. Some imperfect attempts were very
early made in Europe to imitate this
Porcelain, but they were very imperfect till
we received some accots. of its Manu-
facture from some of the Jesuit
Missionaries.

Pere Entrecolles first sent an Acct. of the Manufacture of some Specimens of the Materials, particly of 2 Substances called Kaolin & Petuntse, wh are mixed together in equal Proportions, one of them is a soft Earth capable of forming a tough Mixture with Water, the other a hard Stone, wh they reduce to a fine Powder. These Specimens were immedly committed to the care of Reaumeur by the Academy, & they could not have been put into better hands. Having examined their more obvious qualities, he exposed each to a violent heat & found the Petuntse capable of melting perfectly in a violent heat, but the utmost violence of fire could not bring the Kaolin into fusion.

In the Paper he read to the Academy afterwards, he gives his opinion of the Nature of the Manufacture, that it was a Mixture of 2 Earthy Substances, one

capable of fusion; the other incapable of it, & by the Mixture of wh a Compound is produced wh is incapable of being perfectly melted, but wh undergoes a certain approach to Vitrification in a proper heat so as to acquire that transparency admired in the Porcelain, while the other gives it a beautiful whiteness, for wh this ware is esteemed.

He immedly became hopeful yt Materials might be discovered in France of the same kinds, but finding this not so easy, he had recourse to the Invention of Artificial Materials, & prepared a mixture of flinty Matter with the Ashes of Vegetables, wh baked with a certain degree of heat, united & formed a Mixture resembling the Petuntse in Solubility. He mixed this with the different kinds of Clay resembling the Kaolin, & attempted to compose a Porcelain but without the Success he expected.

Afterwards another Jesuit made ye Porce-

tain the object of his Enquiry, & sent home a particular Acco^t. of the Manufacture, w^{ch} agrees in the leading Circumstances, is more full, & enters more particu^ly into all the details of the Art; & from this detail it is plain y^t. he studied it with great attention & relates the facts with great fidelity.

These different Publications engaged a great n^o. of persons in the pursuit of the Art, & the Consequence is this, they have made a great many discoveries with regard to it, & have put in Practice many different ways of making Ware more or less resembling it. The greatest n^o. have gone upon Reaumeurs Principles, making use of Glass for their Cementing Ingredient. But such Compositions deserve only the name of false Porcelain, they are attended with many Imperfections, the difficulty of giving them the proper degree of fire; wherever Glass enters, the heat must be of a certain degree to make this Matter

cement the other Materials to a certain degree of Closeness, & supposing q.^t the Pieces lose their form & become perfectly fluid so as to collapse in the Cases they are burnt in, & it is very nice in these large furnaces to give the same degree of heat, but some of the Ware gets too little & others too much heat, & thus a great part of the Labour of the Workmen is lost. But tho' they succeeded they are attended with Imperfections, it does not bear sudden alterations of Heat & Colds like the true Porcelain —— However in many different Places the proper Ingredients have certainly been discovered, & they have produced a Porcelain fully equal to the Chinese, the first of these was established in Saxony w.^ch has been long famous for its Beauty & the trouble bestowed on its Decorations; but it is as remarkable for the goodness of its Materials, having all the qualities of the best China Porcelain, the structure

is somewhat different, owing to a little more pains in the Manufacture; when broken the surface of the Piece is much finer & closer on Acco^t. of the more perfect mixture of the Materials.

Some Discoveries were made in France w^ch led to the Principles upon which the true Porcelain is made & Specimens have been presented to the Academy having all the qualities of the foreign Porcelain. In England, tho' several Manufactories have been established on wrong Principles, yet there are certainly at present some going on w^ch produce Porcelain of the very best quality.

The Ingredients are now perfectly known; the principal & most important Materials, is that Matter w^ch the Chinese call Petuntse, & the Ingred^t. most necessary in Combination, is the felt Spat, or Rhombic Quartz. This Substance exposed to a certain degree of heat becomes very brittle, & when calcined to a certain degree,

it is easily reducible to a fine Powder, wch in a violent heat undergoes a perfect fusion, like Glass, at the same time any colours it had before entirely flies off, & it acquires a beautiful whiteness. This Matter mixed in a certain Proportion with a very pure Clay, especially containing a considerable proportion of white Mica or Talk, forms the finest Porcelain, & enables it to endure a violent heat without fusion, while the other Substance gives it that Compactness, texture & semi transparency wch are admired in this Ware. However,

The Art is still very difficult, the Materials for producing it are very rare; tho' the Felt Spat is by no means a rare Substance yet being genly in the Composition of the Garnet, wch contains several other Ingredients, being composed of Felt Spat, Quartz, Talk, & often a qty of Iron, of wch Metal the smallest proportion spoils the whiteness of ye Matter, it

is

is difficult to find Materials of proper Purity. And the only Circumstance wch has given the Chinese such Advantage over us, in the establishing this Manufacture so early, is the plenty they have of these Materials. But such have been found, for the Saxon Porcelain no doubt depends upon a discovery of this kind, & the French Chemists understand this so well of the Specimens of good Porcelain produced in France must have gone upon the same Principles.

In Cornwall they've met with Materials (of the same kind, & have established a Manufacture there, wch is likely to prove a very thriving one; the Garnet abounds there, & consists chiefly of Felt Spat & Rhombic Quartz with white Talk, wch has been found an advantage, & they've found a Clay answering the description of the Chinese Kaolin, wch is of a great whiteness, forms a tough & ductile Paste, & has also another quality of the Chinese Kaolin, it is very

full of white talky Particles, w^ch undergo some Change similar to that of y^e Petuntse, so does no harm in the Composition of Porcelain. This Clay is a Product of the same Stone with the Petuntse, w^ch by exposure to the Air has undergone a sort of decomposition & lost the Principle upon w^ch the flexibility depends, & this Matter after having been gradually washed off by y^e Rain is carried down by the Water & deposited in particular Places. When it is exposed to a violent heat by itself it bakes into a very hard Substance w^ch has the Grain of Porcelain but wants the transparency & is called Stone China, & it resembles some of the Japan China w^ch is admired on acc^t of the beautiful Glazing & bright Colours, while the Chinese Porcelain from an admixture of Petuntse is in some measure transparent.

Among Reaumeaus Discoveries & Ph—

have mentioned that he thot. of reducing Glass to a sort of Porcelain by taking away part of its Vitrifying Ingredients the alkaline Salt, & he got it in several respects to answer the very best Porcelain, so this might be a useful Art in making Chemical Vessels, but no person has yet found their advantage in the establishment of it.

With this we finish the History of Earthy bodies, & next propose to begin the Consideration of the 3d. Class of the Objects of Chemistry, the

INFLAMMABLE
Bodies.

In treating of Inflammations I gave some acct. of the gen. Nature of this Class. The distinguishing Character of these bodies is this, they are capable of Inflammation or have a disposition to be { Sect: 69th.

inflamed. It is necessary to know what is meant by this term?

By the Inflammation of a body is meant an Emission of a great q^ty of Heat & Light, w^h it has not immed^ly received from other bodies; & at the same time attended with a permanent Change of the Nature & qualities of the Matter thus inflamed. This does not happen to any other Class of bodies. No other Bodies are ever found to be a source of heat & Light, or to give out more than they receive from others. In many Cases they suffer a temporary Change of their form by receiving heat but they assume it again. Thus Water becomes Steam or Vapour, but this Change* is only temporary, for if we allow the Steam to come in Contact with a Colder Body, it immed^ly communicates the q^ty of heat it had received & returns to the State of Water, In like manner if we throw in

a great q^ty of heat into some of the fixed Salts they will lose their solid form, & if poured into the Neighborhood of colder bodies they will send out heat & light so as to have the Appearance of an inflamed body, but we soon discover this to be a deception, & y. the q^ty of heat communicated is no more than that thrown in. The fluidity it underwent is not a permanent Change, neither has the Salt proved a Source of heat. But such is the nature of the Inflam^ble Substances y. when heated to a certain degree in the open Air they prove real Sources of heat, sending Streams of heat & light into the surrounding bodies, of great Intensity, & the q^ty is far greater than what is sent into them at the beginning. But this has a certain duration in proportion to the nature of the inflamed body, & when it is over we don't find our Substance returned to its former State, it is no longer

an Inflam.^ble body, but is just of the same Nature & qualities, with respect to heat & light, as the Substances belonging to the other Classes.

But while the Inflam.^ble Substances all agree in this quality, they are very different in other respects, as with regard to their form, some are fluid, some solid, some very volatile, some very fixed when exposed to heat in close Vessels, & have many other Variations in their other qualities. They also differ with respect to the Matter into w.^h they are converted by Inflamm.^n; from some we have a q.^ty of Water, from others a Salt, from others Earth, & from many a Mixture of these Substances in different Proportions. But as they all agree with one another in having this common disposition to Inflamm.^n, this has produced the Opinion that their quality, as inflam.^ble bodies, depends upon a certain Principle the same in the whole Variety, & y.^t in other respects

it depends upon the different Principles with w.ch it is combined; & y.t the Phenomenon of Inflam.n depends upon the Separation of this Principle of Inflammability. For we can restore, to an Inflam.le State, Matter w.ch has undergone this Change, by mixing it with other Inflammable Matter, & subjecting it to a certain degree of heat; & as the same Effect is produced by applying diff.t kinds of Inflam.le Substances, they have concluded y.t it is y.e same Principle in all: thus Sulphur is changed by Inflam.n in to a ponderous Corrosive Salt, the Vitriolic Acid, & it can be restored again to the form of Sulphur by mixing it with Inflam.le Substances, & by subjecting it to particular Operations in Chem.y, in w.ch it is supposed y.t the common Principle upon w.h Inflam.n depends is communicated again to this Acid, so as to restore it to a perfect Sulphur. And for this purpose an Inflam.le

Substance may be taken either from ye Vegetable, Animal, or Fossil Kingdom. But,

Where we attempt to form an Idea of this common Principle of Inflammability, to enquire into the nature of it in its separate State, we are involved in a great deal of difficulty. Some time ago the Chemists used terms for it, wch conveyed gross Ideas, calling it Sulphur Principle, inclining their Readers to believe yt it was actual Brimstone. Dr Boerhaave imagined it to be some subtile fluid, like Spt. of Wine, & actually considered the Spt. of Wine as this Principle. But he had not the opportunity of acquiring yt extensive knowledge from Chemical facts wch is now easily obtained; otherwise he could not have imagined yt Spt. of Wine could have produced all the Phenomena attributed to the Pr. of Infly. When we observe what happens during the dissipation of this Principle, we can perceive nothing but a Stream

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of Heat & Light, or some Modification of Matter upon wc. heat & light depend. But these are rather too subtle to be subjects of much Reasoning & Discussion, they depend upon some Matter perceptible to only one or two of our Senses, so we have little opportunity of examining it. But to support this Idea, we have some remarkable & striking facts, there are not wanting such bodies wc. when merely exposed to the Light of the Sun or day, as attract a qty of it & fix it upon these bodies so as to produce upon them the same Effects wc. are produced by uniting to them some Inflamle. Matter. Therefore these facts wd. lead us to the Opinion that this common Principle when totally separate from all other Matter is either Heat or light, or some very subtile Elastic fluid, upon certain Modifications of wc. the Phenomena of Heat & Light seemedly depend.

With regard to the difficulty occurring w^t. respect to the bodies becoming heavier after the Separation of this Principle, w^c we can easily shew to be the base of the Phosphorus of Urine, Sulphur, & some of the metallic Substances. When treating of Inflamm^n, as an Effect of heat, I observed y^t it was only necessary to suppose y^t this Matter was exempted from the Laws of Gravatation, or rather that it is specifically light, & when thrown into the Composition of a body, renders it lighter than it was before. And we supposed with some of the greatest Philosophers y^t this heat & light depended upon a dense subtile fluid, pervading all other kinds of Matter, & so elastic as to be put in Motion with great facility; & y^t we have manifest Indications of such Matter in the Phenomena of Electricity, Magnetism & Gravitation.

I divide the Inflammable bodies into fixed & Volatile w^{ch} send out Vapours in the State of Inflam^{n} w^{ch} we call Flame. They may be arranged under the following heads, Viz^{t}. Phosphorus, Sulphur, Charcoal, Ardent Spirits, Oils & Bitumens. In this order they are enumerated according to their Simplicity & y^{e} Ease in decomposing them.

Phosphorus.

The Simplicity of this Principle in the Phosphorus, is easily demonstrated, from the strong disposition it has to be inflamed & the fixedness of the other Matters w^{ch} it contains, & w^{ch} may be easily collected free from loss. We are indebted to Margraaf for a more perfect knowledge of this body, & for a Process by w^{ch} it is more easily prepared now than formerly. It is prepared from Urine by evaporating it to y^{e} Consistence

of Honey, & then adding a certain Proportion of Charcoal Dust &c. These are distilled in a Retort; Vapours come over into the Receiver, wh. give a luminous Appearance, & along with these, transparent Drops of an oily Substance wh. is perfectly condensed in the Neck of the Retort, & drop partly into the Receiver, Water being in the Receiver for its Condensation. There is a generation of Air, wh. must be provided for, otherwise the Vessels are burst open & the Phosphorus lost by Inflamn. & from inattention to this particular Circumstance. It was considered as one of the most difficult Operations in Chemistry & only one or 2 persons could sell it with Profit, the Godfreys at London. This Substance first appears in the form of a transparent Oil, or in a Mass resembling Bees Wax, it has a polished Surface upon cutting, in Water it acquires an Opacity & Whiteness by the slow action of the Air of the Water,

but when first prepared it is semi transparent & of a yellowish Colour. When we take a little bit of it out of Water, in a heat nearly equal to that of the human body it becomes perfectly fluid, & assumes the form of a little drop of Oil; upon increasing the heat it arises in fumes & may be condensed without shewing any farther Change in close Vessels. But if the same heat is applied in the Open Air we perceive in the Substance a most violent disposition to Infla^n. Thus when I hold a little of it at a considerable distance above the flame of a Candle on a bit of Glass it burns with an exceedingly bright flame w^h has a great power of burning & scorching Animal Substances. The heat of the human body is sufficient to set it on fire, & it produces most baneful & dangerous burnings. When simply exposed to the Air it is attended with a constant Smoak, & emits a pale bluish Light w^h

is sensible in the dark. — This shews that the Pr. of Inflam^ty is strongly attached to the other Matter. And upon this Circumstance depend a great many of the tricks com^ly performed with it as setting fire to Paper, by taking a Piece of soft spongy Paper, dipping it into a Solution of Nitre, then drying it, & putting in a bit of Phosphorus & folding it up, upon rubbing it the Phosphorus takes fire & sets fire to the Paper w^h burn with rapidity. Or we can set fire to Tow wrapt round a Vial by sticking a bit of Phosphorus below the Tow, then pouring boiling Water into the Vial, or mixing 2 cold Liquors in it, as Oil of turpentine & Water, which produce heat enough for the Inflam^n of this Substance. In like manner we can light a Candle at a Glass of cold Water, a small bit is taken out of the edge of the Glass & a bit of Phosphorus stuck into the part, & a Candle still warm

is applied to the Phosphorus. Thus a great many Experim^ts of Chemical Magic may be made from the knowledge of this Substance.

When this Operation is over the Principle appears in its separate State attached to the Glass. The common way of burning it is to suspend it over a large Glass Vial, that the Vapours may have room, & when a large q^ty of them is condensed they form a kind of downy Substance, but a considerable part attaches itself to the part of the Vessel upon w^ch the Phosphorus is burnt, as appears here from the bit of flask. This being examined is found to be of a saline Nature & has a strong Attraction for Water, it deliquiate when exposed to the Air & turns out nearly one half heavier than the Phosphorus was. The saline Substance thus obtained is not perfectly pure, but still contains a little of the Pr. of Infl^y. so is not perfectly

white, wh. is the Colour of saline Substances in general, but it has a yellow or Orange Colour, & if it is exposed to a strong heat the remaing part of the Pr. of Inflly sets fire to it, & a fetid smell arises, & at length it becomes quite transparent. Dissolved in Water it forms a fluid resembling the Vitriolic Acid in its Density, Weight & Sluggishness. And Margraaf has shewn yt. this is a strong Acid & he has united it with all the different Substances upon wh. Acids have any Effect. But as these Combinations have produced no remarkable discoveries I refer you to the Berlin Memoirs for what is curious with reg: to this Sub~~stance~~ject. Among other Expts. he satisfied himself with regard to the nature of Phosphorus, & the Principles in its Composition. He took a qty of this Matter, mixed it wh. a Proportion of Charcoal Dust, & recovered the Phosphorus in its Inflam.e State, the Pr. of Infl.y disappear-
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ing in this Operation.

One of the most remarkable Properties of Phosphorus, is its emitting a luminous Vapour in the ordinary heat of the Atmosphere. I exposed 3 grains of it, wc. continued to shine for 15 days, & after ceasing it found it had undergone a Change similar to what it undergoes by a more hasty inflamn. the acid attracted humidity from the Air & formed a viscid acid Liquor, so this shining of the Phosphorus may be considered as an inferior degree of Inflamn. wc. being carried on much more slowly than the other, it is not attended with the Production of any sensible degree of heat, only with the Emission of a faint Light. — This quality of shining in the dark is most admired in the Phosphorus, but there are other Inflamble. Substances wc. shew a Phenomenon of the same kind, thus Sulphur heated to a

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certain degree, takes fire & burns with a blue flame, from wc. arises a suffocating Vapour of the Volatile Vitriolic Acid; & heated to a degree below this, it gives out a luminous Vapour, the Light of wc. is much fainter than that of the proper flame of Sulphur, & is not attended with the total decomposition of the Sulphur, no Acid or suffocating Vapour arises. We can see these diff.t degrees of Inflam.n by taking a rod of Iron, one end of wc. is kept in the fire while the other is kept cool, & applying the Sulphur to diff.t parts of ye Rod, in some parts of it the Sulphur will be melted, will become luminous, emitting a pale blue flame, but quite diff.t from the flame of Sulphur when actually set on fire. It is merely an Emission of a small part of the Pr. of Inflff, producing Light without any sensible degree of heat. In like manner with regard to Tallow, if some of it be put upon the Wick of a Candle, just sufficient to extinguish

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the flame, but not enough to cool the Wick, upon blowing away the flame we see a luminous flame issuing from the Wick, for a moment it gives out a pale blue light in a dark Room, some of the Steams of the Tallow undergoing a slight degree of a more perfect Inflamn.^t than what takes place in the ordinary flame of this Substance.

This is sufficient with reg.^d to the Phosphorus of Urine, w.^c is a more curious than useful Substance — It has been recommended as an internal Medicine, but we have got very little Experience with reg.^d to it, & Physicians will be timid in venturing to prescribe it on acc.^t of its great disposition to Inflam.^n

The other most noted kind of Phosphorus is the Preparation called Phosphorus of Alum, w.^c agrees in containing the Pr. of Infl.^y very loosely with some other kind of Matter, in consequence of w.^c the Air is disposed to promote the Separation of the Principle.

The Process for producing it is by adding some Animal or Vegetable Inflam.ble Substance. Some recommend flour, others Honey, others ye Yolk of an Egg &c. all wh. contain a qty of Inflam.ble Matter. The Alum is reduced to a Powder, & the Mixture put into a Ladle over the fire; the Alum is melted, & the heat being continued the Water it contains evaporates, & a fixed Compound of Earth & Acid remains combined with the Inflam.ble Matter of the Vegetable or Animal Substance; Before this is scorched to the greatest degree it is taken out & reduced to a powder, This is put into a Matrass with a Cylindrical Neck, & placed in a Crucible surrounded with Sand, & these are put into a furnace. Heat is then applied to make the Matter red hot, the Vegetable Matters are driven off with the Steams, & a portion of the Acid of Alum drives & is combined with a part of the Pr. of Infl. & changed into a sort of Sulphur. But there is another part of the Acid remaining adhering to the

Earth of Alum, it retaining diff^t. portions of the Acid with diff^t. degrees of force; or rather there is a Compound of the Acid with the Earth of Alum & the Sp^r. of Inflty. Now in such a Compound any 2 of the Ingredients will cohere but loosely, the Sp^r. of Inflty will cohere the less strongly to that Acid, & the Acid is united with the Earth of Alum; hence when exposed to the Air there is heat enough in it for setting the black powdery Substance remaining on fire.

There are one or two more Products of a similar nature, w^ch are inflam^le Substances containing the Sp^r. of Inflty with weaker force, & being exposed to the free Air immed^ly parts with it, M. Homberg in making Exper^ts. upon the Calx of Antimony, got a Mass w^ch in breaking the Crucible, immed^ly took fire.

But there is another Class of bodies, to w^ch the name of Phosphori is more properly applied, & are called Pyrophori, I mean the Bologonian Stone & other Preparations produced

upon the same Principles.

The Bologonian Phosphorus was the first remarkable Substance of this kind; it is from a Stone found in the Neighbourhood of Bolonia in Italy. It is of an irregular figure & of a plated Structure, &c. (and from the Exper^ts of Margraaf upon it, it appears to be gypseous Spar. It is produced by reducing it to powder, making it into a Cake with Gum Tragacanth, & laid on Charcoal, w^ch is allowed to burn out, & by this means it is calcined. After it has been exposed to Light if it is carried into a dark Room it appears all over luminous. And he found the same quality to be more or less possessed by the Spar.

Another Chemist, Mr. Canton of London, added together a pure Lime & a pure Sulphur, w^ch are reduced to a fine Powder, put into a Crucible, & exposed to a pretty strong fire of a Blacksmiths forge, & the Compound assumes the nature of the Bologonian Stone, the Vitriolic

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Acid receiving ~~receiving~~ a Portion of the Pr. of Infly from the Steams of the Charcoal. I once considered this sort of Phosphorus as similar to the Phosphorus of Urine & of Alum, as a Substance of the Inflamle. kind & containg the Pr. of Inflamty in a loose & detached State. But some very curious Expts. upon ye. Species of it have shewn it to be of a nature totally diff.t & exceedingly curious. If it was an Inflamle. Substance & the shining occasioned by the Pr. of Infly it shd. at length lose this property of shining, but the fact is this, tho' it is impaired in its quality & goodness if it is kept in a negligent manner, but if shut up in a close Vessel, it may be kept for any length of time without any change of its qualities, so that it does not shine by parting with any Principle it contains. Mr. Canton has further shewn that it manifestly receives a qty of Light, & yt. the Light wch. it emits, is this Light imperfectly fixed in it for

a short time & emitted again when carried into the dark, as appears from a no. of Expts. It is observed to shine brighter in Summer than in Winter, but continues to shine for a shorter time. This led him to apply a stronger heat, as yt of boiling Water, & it still shone brighter but the duration was shorter. Further, some pieces having been kept in a dark place for a very long time, upon being heated emitted a faint light, & after this disappeared, the same pieces upon being put into a dark place ever so long, could never be made to shine till they were exposed to the Light of the Sun. And he found it to be perfectly unchangeable in close Vessels, & yt it is disposed to retain a certain qty of the Light with considerable force & obstinacy. Some of it wch had been kept in the dark for 6 Months was found to give a considle degree of Light when laid upon a piece of hot Iron. Upon the whole it

it is plain that this Phosphorus receives the Light of the Sun, attracts it, & keeps it in some measure fixed in it for some time, but parts with it gradually in a dark place, & yt. it still retains a certain portion with consid^ble. force wc. is only separable by the Application of a certain degree of heat.

This gives us some new & curious Information with reg^d. to the Nature of Light, if it can be received & retained in bodies for some time, & may be considered as in a fixed State, but upon applying a certain degree of heat it returns to its ordinary appearance.

Father Beccari has found some degree of the same quality in a variety of other bodies, yt almost all Substances of a white Colour, as Paper, Cotton, Linen, white Stones & Sand, &c. upon being exposed to the Light appear luminous when carried into a dark place; He examined whether heat had the same Effect upon them as it has upon ye Bolognian

Phosphorus, & he found y^t. a great q^ty attracted Light & emitted it in this way tho' very faintly & imperfectly. These Exp^ts. require a particular Apparatus & an Eye accustom-ed to very faint Lights, & the transition must be very sudden. Beccari made a sort of Chair with a kind of Lanthorn, w^{ch}. being turned round bro^t. them into the dark be-fore his Eyes without admitting any Light into the place where he was sitting. I was once induced to imagine, from the Light ap-pearing so short a time, if the Shining might be owing to the refraction of the Rays, tho' the Motion of the Light is very swift, yet w^n. a q^ty of it is produced in a Room by y^e burn-ing of a Candle, upon putting it out, the Light flowing to all the diff^t. Corners of y^e Room can't be suffocated & destroyed in a moment but must be reflected a n^o. of times before the Rays can be absorbed. But the time for this is so very short y^t. we can't perceive it, &

the Light appears to disappear the very moment the Candle is extinguished. But in Paper, &c. w.ch have very numerous transparent small parts, the Light will be refracted a great n.o of times before it is absorbed & suffocated. Whether this may be the occasion of the Light observed by Father Beccari I will not pretend to say, I suggest it only as a hint.

But if these Substances will shine more quickly by the Application of heat, I sh.d consider them as of the same nature as the Bolognian Stone, or retaining the Light with a certain degree of force so as to part with it afterwards in a gradual manner —

With this we finish the Acc.t of the Phosphori — The Substance w.ch comes next in Simplicity is

Sulphur

It is indeed equal w.t respect to Simplicity,

consisting only of the Pr. of Inflam combined with an Acid Salt, w^ch we noticed when speaking of the Vitriolic Acid. I also observed y^t the Pr. of Inflam adheres but weakly to the Acid, it being among the most easily Inflam^ble Substances, & that by long exposure to the Air it is liable to become sensibly Acid in conseq^ce of a very slow waste of the Pr. of Inflam^n.

Stahl imagines y^t Sulphur contains only one 16^th part of its Weight of this Principle. The Exper^t he made was by uniting the Sulphur with a fixed Alkali so as to form a Hepar Sulphuris w^ch is exposed to the dullest degree of red heat & to the Action of the Air, so that the Principle of Inflam is separated by a slow & gradual Inflam^n & only y^e Acid remains united with the Alcali, & we obtain a Vitriolated Tartar w^ch we find to be somewhat lighter than the Hepar Sulph^is But he was ignorant of the fixed Alkali containing a greater q^ty of Air, w^ch separates

when it is converted into a neutral Salt about 1/4 part of its Weight. So yt by separating the Pr. of Infly we increase the Weight instead of diminishing it. I formerly took notice of its fusibility & Volatility, & I mentioned ye conseqce of burning it for the Acid.

We began to consider Sulphur. When speaking of the Vitriolic Acid we anticipated many Observations concerning it, as with reg.d to its Composition, that its Principles cohere but slightly, so yt it is one of the most inflamle Substances, & therefore is made use of for Matches &c. — Lect. 71st

When set on fire it suffers a Decomposition of a certain Portion of the Pr. of Inflamy easily, but retains another Portion more obstinate by wc forms the Volatile Sulphureous Acid, in wc it resembles the Phosphorus & other Inflamle bodies, from wc by Inflamn we readily separate the Pr. of Infly except a certain portion wc remains adhering more strongly.

We took notice of its Nature with respect to the Alkalies & Quicklime. It can be combined with the Vol: Alk: in its Caustic State. We mix together Sal Amm:c Quicklime & Sulphur, when exposed to heat the Sal Amm:c is converted into Vapour, this is applied to the Lime, w.ch attracts the Acid & disengages the Vol. Alk: in the form of a dry Salt, w.ch acts powerfully on the Sulphur, & arising with it constitutes a volatile Hepar Sulphuris. Stahl calls this the Volatile Tincture of Sulphur, but it has never been made use of in Medicine. We also explained the Effect of Sulphur upon Nitrous Salts in deflagration. The Acid of the Sulphur combined with the Alk: forms forms the Sal Polycrest, w.ch is a Species of Vitriolated Tartar, & with Cubic Nitre or Glaubers Salt.

We need only add its Origin & the Operations it is made to undergo. It is produced by nature in considble qty in its pure & separate State; chiefly in the Neighbourhood of Vulcanoes.

It is found sublimed in fissures & cracks of the Rocks by the Subterraneous heat, & even the soil covering the Surface abounds wt Sulphur.

In Italy it is so abundant y. the greatest part of the World is supplied from that place. It is called native Sulphur, or Sulphur Vivum, & is more or less pure; sometimes so pure as to be transparent; on other occasions it is mixed with more or less Earth. When found in this state it only requires to be refined, either by melting in large Vessels, & keeping it so till the Impurities fall to the bottom when it is poured into Moulds; or by sublimimg it by particular Operations.

But a great deal of the Sulphur prepared in other parts of Europe is obtained from certain Ores of Minerals; most of the Ores of Metals contain more or less Sulphur, but it is chiefly obtained from Pyrites; they are ponderous Masses, very hard, & having more or less of a yellow Colour & of the Lustre of

the Metals. Such Masses sometimes occur among Coals & are gen^ly of an irregular figure, but sometimes of a Cubical form, & we sometimes meet with Animal & Vegetable Substances penetrated with this Matter. In some parts of England, Wood is penetrated with Pyrites & Shells are found filled with it, w^ch shews y^t they have been once in a State of perfect fusion; Some of these Specimens are quite transparent, tho' they are gen^ly considerably opaque, & the transparency is easily destroyed by melting the Sulphur when it assumes its ordinary Opacity.

The Sulphur is obtained from these Substances by a sort of Distillation; the furnace consists of two Walls parallel to one another & these are penetrated with a Sort of Retort w^ch is open at both Ends, one end is small & has a Receiver fitted to it, & the other is wider & serves for putting in the Pyrites, & then is closed up with a piece of Earthen Ware

Ware & closely luted. The Sulphur sublimes & is condensed in the Receiver, & the remaing Matter is raked out where it was put in. It is genly Iron, of wch the Pyrites contain more than it does of Sulphur, & hence its great Weight. It is in reality an Ore of Iron, but is never used as such, as the Iron can't be extracted with Profit, & turns out very bad. The Sulphur has genly a little Iron or other Impurities adhering to it, wch are separated by melting the Sulphur & preserving it liquid in Iron Vessels, whereby many of the Impurities are separated, hence it is made into these Cylindrical forms in wch we have it. We have it still purer under the name of Flowers of Brimstone, wch are obtained by Sublimation, & this Process can be carried on to a great extent & with little Expence. They use a large Iron Pot, & the Receiver is a Chamber built on purpose wch is shut every where except

a small opening for a Man to enter; the Walls are lined with Tiles, & all communications with the external Air cut off. So the Steams of the Sulphur circulate thro' the Room & condense upon the Walls. The flowers are attended with a slight degree of Acidity, for at first when the Sulphur is heated, the Room being full of fresh Air, small portions of the Sulphur are burnt, & a qty of Acid produced, wh. attaches itself to the flowers. It is therefore proper to wash the flowers to prepare them for the purpose of Medicine.

The Vitriolic Acid, now used, is got by burning the Sulphur. The particular manner is kept a Secret, as the Process turns out very lucrative. They seem to use a proportion of Nitre, wh. is recommended by Lemery, for producing a more compleat Inflamm.n & more perfect Decomposition of the Sulphur, but they have a particu-

lar Apparatus of Vessels, &c. whereby they have brot. it to the Market cheaper than when it was prepared from Vitriol.

In the ordinary way of burning the most of it arises in a volatile Salt. This has been considered as a Curiosity in Chemy, & Stahl has given a Process for preparing it in this Volatile State. His directions are to burn the Sulphur with a small flame, so as to produce as imperfect a decomposition as possible; & to condense it we suspend a bone of Linen dipt in a Solution of alkaline Salt, for tho' it is not condensible by itself yet the Attraction of the Alkali fixes it, they uniting & forming a compound Salt, & the Wet Rag becomes by degrees husky & dry, & the Salt is rub'd off in the form of a white Powder, the Linen is wetted again, & the Operation repeated till a sufficient qty is obtained. We now find it a Vitriolated

Tartar containing the volatile suffocating Acid of Vitriol; & upon adding a little of the fixed Vitriolic Acid it emits pungent suffocating Vapours resembling those from burning Sulphur, the Phl. of Infl. diminishing its readiness to unite with the Alkali; but tho' it suffocates Animals, it is by no means a Corrosive Substance, but the suffocating quality proceeds from the Pr. of Infly wc. it contains in a loose State; when applied to the tongue it by no means tastes acid, it has only a Sort of astringent taste, & other Exper.ts shews a very small degree of Acidity, approaching nearly to that of Sulphur, wc. is still mild from being combined with a still larger Proportion of the Pr. of Infly.

The other Products obtained are the Lac Sulphuris & Balsam of Sulphur wc. we shall consider wn. we speak of the Oils, & when we come to consider the Pharmaceutical Preparations.

We proceed to the next form of Inflam^le^ Matter,

Charcoal.

This deserves notice, being of a very particular Nature, compared with the other Inflam^le^ bodies. It contains a large proportion of the Pr: of Infl^ty^ & is often used when we want to transfer this Principle.

It is produced by burning Wood with a smothered fire, when the Wood becomes red hot it is extinguished by covering it. The Art of doing this is described in the French Work where the Arts & Trades are described under the Article Charbone, what we com^ly^ call Charcoal is thus obtained from Wood by heating it gen^ly^ in close Vessels, till it is red hot, &c^a^. But it may be obtained from all sort of Animal & Vegetable Substances, & also from the fossils of the bituminous

kinds. All these Substances contain some Earth with a consid^{ble} q^{ty} of Volatile Ingred^{ts} of w^{ch} Water is the chief. These arise during y^{e} production of the Charcoal, the Water rises first pure, then combined with the Saline Matters; after a ~~he~~ red heat is produced all the Volatile Matters are expelled & the Charcoal remains, w^{ch} consists of Wood, Bones, &c retaining the forms of the Substances from w^{ch} it was produced.

One remarkable Singularity of the Charcoal is this, it is perfectly unchangeable & incorruptible unless when red hot. It is a common Practice to scorch the Ends of Stakes w^{ch} are to be drove into the ground, to make them durable, w^{ch} has a surprizing Effect, but when they are perfectly charred we have no Experience of any End to their duration. We meet with bits of Wood so charred lying at a consid^{ble} depth in the ground, w^{ch} undoubtedly are of very great Antiquity, & their

Structure is no way changed. It not only resists the Effects of the Air & Moisture but the most penetrating Matters, nor has any thing been found wh acts upon it so long as it remains cold

When heated to a certain degree, there are several Substances wh begin to act upon it, as the Vitriolic & Nitrous Acids, the Vitriolic Acid either by itself, or when combined with fixed Alk: By itself when distilled wt. Charcoal, it dissolves it, & is changed into the Volatile Suffocating Acid. Combined with fixed Alk: it is capable of fusion, & is changed by it into Sulphur. The Nitrous Acid acts upon it with some degree of deflagration, but more readily if combined wt. an Alk: wh enables it to endure a red degree of heat. The Acid of Phosphorus unites wt. it & forms the Phosphorus. And the Metals by means of it are ~~r~~ reduced to their Metallic State. Upon the whole it is useful as a

readily furnishing the Pr. of Inflty to many other bodies. It seems to be almost totally spent in giving out this Principle, as the Ashes remaing dont weigh above the 50th part of the Charcoal; but it also appears to send out a great qty of Volatile Elastic aerial Matter, wch vanishes immedly from our Senses, & so escapes our notice, for in burning it taints the Air more than any other Inflamble Matter. It has been noted for this Effect, & many Accidents have happened from the Air being tainted with it.

Tho' it is decomposed by Acids, & by Salts containg Acids having a strong Attraction for the Pr. of Inflty as Nitre, there is a constant Succession of Explosions of an Elastic Matter wch is produced in such qty as to occasion the Charcoal to be thrown out of the Crucible, & ye same Appearance does not attend the deflagration of Sulphur wt. Nitre, tho' it burns more violently, produces a more intense Light & Heat, & the very

very great force of Gun-powder when inflamed, proceeds from a q^ty of Elastic aerial Matter produced in the Moment of its Inflam^n & the Elasticity of it is increased to a greater degree by the intense heat attending the Inflam^n of Gunpowder. That this is the Case has been proved by many who have made Gunpowder the Subject of their Enquiry, as by Robins, who tried it in Vessels strong enough to contain it, w^ch were made close & having room enough for the Elastic Matter to expand itself, & allowing the Vessels to cool, a great q^ty of Elastic Air rushed out of it, w^ch had been generated from the Powder. But Gunpowder has not this power without the presence of Charcoal. When we attempt to make it with Sulphur alone, w^ch is a more Inflam^ble Substance, it has no Effect, there is a deflagration, but not Explosion. Indeed the Pulvis fulminans has apparently a still more violent Effect, tho' it does not contain Charcoal.

but the nature of y^t. seems still to confirm the Notion, for it contains fixed Alkali, w^c. must contain a great deal of Air, otherwise it does not make the Pulvis fulminans. I've tried it w^t. Pearl Ashes, but these don't contain a suff^t. q^ty of Air, so I now use an Alkali saturated with Air, for the Purpose, & I have it of a very remarkable Strength, w^n the other Ingred^ts the Sulphur & Nitre produces an Intense heat, the Air is driven off with such rapidity & violence as to give that loud Explosion — In the Production of Phosphorus the Separation of this Elastic Vapour also appears by blowing up a q^ty of the Charcoal Dust into the Receiver. And in reducing Metals to their Metallic State there is an Ebullition w^c freq^ly renders this Process troublesome.

So, Charcoal may be considered as y^e Sulphur of fixed Air consist^g of the Pr. of Infl^y combined with a Volatile Substance w^c in its separate State is disposed to assume an Elastic

Vapour in the ordinary Heat of the Air, but thus combined it is very fixed in close Vessels, but when the Air is admitted it assumes the form of this Vapour, & is inflamed when red hot ——— The next Inflam^le. Subst: Lect: 72^d
Substance in this order is Vinous or

Ardent Spirits.

This kinds of Inflam^le. body have the Name Spirit according to the Practice of Chemists who gave it to all Liquors afforded by Distillation, & of Ardent or Inflam^le. to distinguish it from the saline or other kinds of Spirits. It is also com^ly called Vinous from its Origin, & in its pure State, Rectified Sp^t. of Wine, & when reduced to the greatest purity Alcohol.

Inflam^le. fluids are produced by fermentation; from certain Vegetable Substances, those yielding the most of it are either the

sweet Juices of Vegetables, such as ye Juices of numerable fruits wch have a sensibly sweet taste, the blood or Juice of some Trees, or the Matter in wch the Sweetness resides. The saccharine Matter extracted from these Juices & dissolved in Water, as Sugar, is capable of affording a fluid of this kind. Raisonous fluids from wch the Water has been evaporated, & having a saccharine Matter condensed in a solid form dissolved in Water affords a Liquor wch will ferment & give a large Proportion of this Spirit. A similar Product may be got from Grain or other farinaceous parts of Vegetables, & from some of the Roots, if these are first malted, wch changes them into a sweet Substance, similar to Sugar, are easily brot into a state of fermentation when diluted with Water. But they may be brot into a fermentation without malting if they are reduced to flour & mixed with Water & ma-

naged properly. The nature of this fermentation will be considered when we treat of the Vegetable Substances in general. It is sufficient here to mention y.t all kinds of vinous Liquors are produced in this way.

The Spirit thus produced, while present in the fermented Liquor is diluted with a large q.ty of Water & with some tartarous or acetous Acid, some mucilaginous Matter, & a small q.ty of subtile Oil. The Proportion of Spirit to Water is but small, not above 1/8 in the strongest Wine & in these reckoned strong & in Malt Liquor still less. Newman has given a table of the Proportion of Ardent Spirits in the different Liquors.

To separate the Spirit in its purest State requires several Operations. It is first distilled in a common Still, & the Spirit being very volatile rises first & is condensed by itself, tho' a consid.le q.ty of Water rises along with it; & a great part of the Water, with the Acid, &c. remain behind. But besides the large proportion

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of Water; another Principle still attends it, the subtile Volatile Oil is intimately blended with the Spirit, & is of a different flavor according to the nature of the Spirit, & this is what occasions the diversity in point of flavor; for when purified to ye highest degree they are all alike. To this is owing the disagreeableness in the Spirit of Grain, & it shews it more remarkably when diluted with Water, when it is less perfectly dissolved with the Spirit it gives a milky hue to the mixture, & the particular flavor of ye Oil is more manifest — This is separated by distilling it over again with a gentle heat, wch is gen^ly done in Balneo, with never more heat than that of boiling Water; the Oil is rather less Volatile, & this is also necessary to separate more of the Water, & it may be necessary to repeat these Rectifications several times, but a q^ty of Water always rises with the Spirit & a little of the Volatile Oil. Some

have proposed an Apparatus to secure Success, a Still provided with a very tall head ri-sing like a Cone to a consid.le height, &c. y.t the Vapours may suffer some Condensation as they arise, & only some Spiritous Vapours reach the top to be condensed by cold Water. But still these Machines can't be made to bring the Spirit to a greater degree of Strength, at least when working on a small q.ty of Spirit; when large quan.s are distilled, if the fire be applied with some Caution a por-tion of the Spirit arises first remarkably strong, much stronger than can be easily prepared by any other means, but in distilling a small q.ty it is necessary to have recourse to an Elective Attraction to separate the Water. The com-mon Method is to employ the Vegetable Fixed Alkali partic.ly that contained in Pearl Ashes; when a q.ty of these is added it falls first to the bottom, but it is grad.ly dissolved, & remains at the bottom of y.e Vessel without

mixing with the Spirit, forming a transparent fluid like a heavy Oil. Having attracted the Water from the Spirit to make the Spirit stronger it may be poured off into another bottle & more alkali added. The Spirit acquires from the Alkali a yellowish Colour, & a disagreeable taste from the Salt acting on the oily part & giving it that colour, therefore to separate this Alkali the Spt. is again distilled in a Retort with a gentle heat, the Spirit rises pure & colourless & of a very great degree of Strength — Or if fixed Ammoniac or Compound of Calcarious Earth with Muriatic Acid may be used, this dissolves in the Spirit but unites most strongly with the Water & if the Spirit is distilled the Water is retained by that saline Compound, & the Spt. rises with less trouble. The Objection is this, the fixed Ammoniac is not so easily to be had while the fixed Alkali is always at hand. Besides the fixed Alkali

always uniting with the subtile Oil, helps to refine the Spirit to a greater degree; freeing it from a Portion of the Oil— If it is not sufficiently pure there is another Operation, the adding a little Alkali, wc. dissolves in the Spirit & unites most strongly with the oily Principle, so yt it acquires a dark yellow or brown Colour, & then being distilled it rises free of any flavor & fit for the nicest Operations in Chemistry.—

And thus we have a subtile penetrating & inflamble. fluid, wc. is distinguished from the rest by several remarkable qualities.

1 It is one of the most difficultly frozen bodies of any we know, there is hardly any fluid so much expanded by heat or contracted by Cold, so is fit for thermometers, At 174° of Farenheit it is converted into an Elastic Vapour & it evaporates spontaneously very fast, & in every respect is a Volatile fluid. In Vacuo it is con-

verted into Vapour in a heat below any of the ordinary heats of our Atmosphere, & upon this some of the Phenomena of the Pulse Glass depends; it consists of a head, Tube & Ball, sealed up with a qty of Spt. of Wine enough to fill one of the Balls & a small part of the Stem, & when held in the hands, with one end a little higher than the other, the Spt. of Wine begins to boil.

Another well known quality of this fluid is its great Inflamn. The Vapor is highly Inflamles whenever approached by flame, & unattended with the least appearance of Smoake, & there is as little appearance of any Matter being left behind. So, Dr. Boerhaave considered it as a pure Pabulum Ignis, as being totally spent & consumed in producing heat & light, so considered it as the Pr. of Infly, imagining yt. difft. bodies were inflamle. in proportion of the qty of Alcohol they contained. But it is a gross

Error, for it contains a great qty of Water for its basis, & wch is only altered by being combined with a moderate Proportion of the Pr. of Infly. He acknowledges yt a Watery Vapour is emitted, but supposed yt this is owing to the difficulty of separating the whole watery humidity, wch too might be separated by a proper Method. But the qty is so great yt it can't be accounted for in this way. When we burn it in proper Vessels, keeping their Sides cool, Water will remain condensed equal to 1/3; & if a Vessel be suspended, equal to 1/2 of the Weight; & a still much greater qty may be collected; & I have not doubt yt the Weight of Water is fully equal to yt of ye Alcohol.

The qty of the Pr. of Infly is manifestly small; as appears from the weak Light, & inconsiderable heat, it gives out when burning. It is not capable of producing near so much heat as the Oils

Salt may be considered as an Inflam^ble Substance containg less of the Pr. of Infly than any of this Class.

The only other Ingred^t in the Composition is a subtile acetous Acid, probably serving to unite the two Ingredients. The Presence of it appears from some Exper^ts of burning it in a small Vessel, it escapes in burning, but we can observe a hollow Cone of inflamed Vapour produced, including within it another Vapour not consumed for want of Communication with the Air. So the acetous Acid passing thro this Cone of fire must be totally consumed & destroyed; so the only Vapour arising is pure Water, & it arises so slowly y^t it is dispersed thro y^e Air — This is enough with reg^d. to the Nature of Alcohol with respect to heat.

We next consider its qualities in Mixture with other bodies. One of the most remarkable is its mixing with Water in

any Proportion; w^{ch} no other Inflam^{ble} body will do, & this probably owing to its being so much of a Watery nature; they've a considerable Attraction for one another, so y^{t} a sensible heat is produced by their union, & either of them in any Case will desert other Substances in order to unite w^{t} one another, so the Spirits w^{ch} dissolve Oils & resinous Substances, will desert these to mix with Water, & again Water w^{ch} dissolves a Variety of Salts, may be made to part with many of them upon adding Sp^{t} of Wine. It is difficult to obtain this Spirit in a Strong State; for tho' in their separate State the Spirit is much more volatile than the Water, its Volatility is considerably repressed by their union.

Many of the saline Substances act upon the Sp^{t} of Wine. We noticed that the Vegetable fixed Alkali attracts Water from it, & if much Alkali be used, a small part of it

dissolves & gives it a yellow Colour & disagreable taste; & if the Spirit is allowed to retain the Alkali it is found to be a more powerful Solvent. So the Chemists have studied this way of making tartarized Sp! of Wine, as Dr. Boerhaave, who considers the Art of making it rightly, a nice & difficult Operation: We first use a Spirit as strong as possible, & we are to have the Salt of Tartar well calcined & put in perfectly dry & hot, for if either the Spirit has Water, or the Salt gets Water from the Air, it will not succeed. And this is all you'll get in Books. But I must add that this Account of the Matter is only applicable to the Alkaline Salt in a middle State of Causticity, as Pearl Ashes. A perfectly Caustic Alkali dissolves perfectly & uniformly, & ij. in the strongest Spirit, & soon after it is thus dissolved it communicates to it a very deep yellow or red Colour, especially if it is Digested a little. This explains the

nature of tartarized Spirit of Wine, & points out a Process by wc it may be very easily prepared. That prepared by Boerhaave is only a Spirit wc has dissolved the most Caustic part of the common fixed Alkali. But taking the Alkali entirely Caustic we can dissolve almost as much as we please & this acting upon the Oil gives it that deep Colour, wc is reckoned a proof of the richness of the alkalized Spirit. By this means too we have an easy Method of justify the Expert wc Van Helmont pretended to have made, & Boerhaave tried wt such Care, Vizt. the Resolution of Spt. of Wine into Oil & Liquid, (See the Expt. in Mr Quer & what happened to Boerhaave) I've tried it myself & found yt after the Caustic Alkali had communicated this brown Colour, if it is distilled, we get an Alkali in some measure neutralized, having attracted an Acid of the Acetous kind. Whether by a Repetition of the

Operation more of this Acid may be separated & more of the Acid decomposed I can't tell. It w^d. require a great n^o. of Repetitions, & after all it is evident that this has Water for its Basis.

As the Effects produced by an Alkali perfectly Caustic upon Spirit of Wine are different from those produced by the Alkali in its ordinary State of Causticity, so if we take one saturated, it is so much neutralized by the Air that it has much less Attraction for Water & we find y^e Sp^t. of Wine is capable of separating it.

From these particulars we can explain a Remark of Newmans with reg^d. to a particular Tincture, called the Spirit tinctured with the Reguline Caustic. A Sp^t. of Wine is made to dissolve a q^ty of Caustic Alkali, & upon adding some of the Sp^t. of Sal Ammon^c an Ol: Tart: will separate, a strong saline Liquor will be found at the bottom, for the Vol: Alk: furnishes to

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the Caustic fixed Alkali a q^ty of Air, so as to reduce it to the Mildness of common Pearl Ashes, in w^ch State it separates from the Spirit.

The Relation of Vol: Alk: to Sp^t of Wine is somewhat similar to y^t of the fixed in its milder State, it will not mix with the Spirit of Wine but is precipitated.

But the Exp^t. with the Vol: Alk: most taken notice of, is the sudden Precipitation of y^e Salt from Water by means of Sp^t of Wine, forming the Offa Helmontij. Boerhaave describes it as being difficult to execute on Acc^t of the great Strength of the Spirit w^ch was necessary. To a q^ty of the Sp^t. of Sal Ammo^c add an equal Weight of strong Sp^t. of Wine, it is poured on slowly to float on the Surface of the Alkaline Spirit & they still remain perfectly fluid, but if they are suddenly shaken the Mixture becomes muddy, & in some Cases perfectly Solid. This Boerhaave admires as an Example of the Production of a very

subtile Soap; he was an admirer of all saponaceous Mixtures, & tho.t this one of y.e most curious of any, & as one of the most subtile & penetrating of any of the Mixtures, as containg the most subtile fluids of the Inflam.le substances, combined with the most Volatile & subtile of the Alkalies. But it has only the Appearance of Solidity, by the most copious & sudden Precipitation of the Vol: Alk: the Sp.t of Wine uniting with the Water disposes the Alkali to separate in Crystalizations, w.ch are very small, & the fluid remaining is entangled in the Pores as Water is in a Sponge; the Sp.t does not at the same time unite with the Caustic part, but it can be united more perfectly with the Caustic Vol: Alk: merely by mixing them together.

Such are the Effects of Sp.t of Wine added to alkaline Salts,

We next propose to consider the Effects of mixing Sp.t of Wine — Sect: 73.d

with the different Acids w^ch^ is a Subject abounding with curious Discoveries. We shall take them in the usual Order.

The Vitriolic Acid is known to have a strong Attraction for Water & the Prof. Inflam^le^ the chief Articles in the Sp^t^, & they unite w^th^ remarkable Violence & Impetuosity. I shall make a mixture in the Proportion of equal parts by Weight, & two parts by Measure of the Spirit of Wine to one of the Acid; & it is necessary to make it in a Vessel of such a form as will not readily break by this Application of heat, as a consid^le^ degree of heat is produced. We first put the Sp^t^ of Wine into a Retort, then pour in the Acid with a funnel, directing it ag^t^ the Side of the Retort that it may run down along the Surface to the bottom without mingling much with the Sp^t^ of Wine, then by gentle Agitation we bring about the Mixture, w^ch^ must be performed with a good deal of Caution

& Patience, the Spt. of Wine is presently made to boil, every time I bring up a qty of the Acid by agitating it there is a Puff or Ebullition in the Spt. of Wine, if the white flint Glass of wh: the Retort is made & the round globular form equal in every part is remarkably adapted for bearing troublesome Alterations of Heat. After ye greatest part of the Acid is thus mixed, the last part of the Mixture is performed without any of these violent Puffs, the Mixture now requiring a little more heat to make it boil. This Mixture has not a little engaged the attention of the Chemists on acct. of the curious Products it affords by Distillation; So I set it into a furnace already heated & fitted to receive the Retort, & for luting on the Receiving I use a Paste of Flour & Water. When the Mixture is distilled with a brisk heat we perceive a fragrant & peculiar Odour diffused,

& a clear limpid fluid is condensed in the Receiver, while what remains in the Retort is of a dark colour, & when near ⅓ has come over it is time to stop^t. We find in the Receiver a subtile fluid w^ch is very volatile, & w^ch mixed with Water shews itself to be of an oily nature, it floats upon it, & when they are mixed a small q^ty like the Aromatic Oils dissolves in it. This oily Liquor is called the Etherial Liquor of S^r Isaac Newton. It is more proper to call it Vitriolic Ether, or Naphtha Vitriolica. It has several very curious Properties. The reason for stopping when about ⅓ is come over is this, the Matter in the Retort begins to emit Steams of the Sulphureous Acid w^ch w^d spoil the fragrance & other qualities of the Ether; & continuing the heat the Vol: Acid w^d come over in such q^ty & with such Impetuosity as to blow up the Mixture into a black foam & to burst the Vessel in Pieces; if

we want to continue the Operation we apply a fresh Receiver & the greatest part of the Vitriolic Acid comes over in its suffocating State mix'd with a bituminous Odour rendering it still more disagreable; Sometimes along with this a greenish Oil arises called Ol: Vitr: dulcis. It has a peculiar Odour, a Mixture of the Odour of the Ether & Sulphureous Acid; and Beaume who has investigated a no. of particulars with regd. to the Ether has shewn yt. it is a Compd. of these two, & that by rectifying it by an Alkali to attract the Acid it is changed into Ether. While the Distillation goes on in this manner the Matter in the Retort becomes blacker & thicker like Pitch or Tar, & passes on to a State of Charcoal. It is remarkable yt. many of these Effects can be prevented by adding a qty of Water after the Ether is obtained, the Matter in the Retort turns out a pure Vitriolic Acid, the Water by its Attraction for the Acid diminishing

its Attractions for the Inflam^le. Matter and preventing the Cohesion.

This Distillation is gen^ly performed for the sake of the Ether, & as this is the desirable Product, we must point out the manner of obtaing as much of it as possible.

1^st. The 2 Liquors must be mixed together in the Proportion I've used, or a little more than double the measure of Sp^t. of Wine, w^ch Beaume found to be the best; if more Sp^t. of Wine is used it rises first unchanged, if less there is less Ether produced & the Acid rises sooner in these suffocating Vapours. With regard to the Management of the heat, M^r. Quer recomm^ds very gentle heat from the beging, & the use of the Lamp furnace; but it is found y^t a quick distillation answers best for obtaing the greatest yield of Ether & w^t. least trouble; but we must take care to secure the Condensation by applying Cold Water or Snow to the Receiver, & we must be watchful y^t none of

the Sulphureous Acid rises, wch we can perceive by attending to the Odour of the Steams, & making a small hole with a Pin for ye purpose. A small qty of the Acid however generally gets over, wch makes it necessary to rectify the Ether; & a small portion of the Spirit of Wine also gets over at first unchanged. The Rectification is performed in a very tall Vessel, as the Spirit of Wine is a very volatile Substance a Matrass with a tin Pipe adapted to the head of it & wch conveys the Steams at right Angles to be condensed in the Receiver when they are mixed with a small qty of alkaline Salt or Quicklime. A heat no greater than Animal heat is sufficient for this Purpose.

I observed yt it is capable of mixing in a certain Proportion with Water, & this is the best way of giving in the way of Medicine, as by adding 10 times its bulk of Water to it, & in this way it can be easily divided into small doses.

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It is the lightest of all fluids, floating on Spt of Wine, a certain portion only mixing with it. It is extremely volatile, a little laid on the ground disappears in a short time & spreads its flavor all around. 100° of Fahrenheit is sufficient, even under the Pressure of the Atmosphere, to make it boil, so that in Vacuo its boiling point is far below Frost, & was it not for the Pressure of the Air keeping its Particles together it wd always appear in the form of an Elastic fluid, like Air. The Expert is described in the Physical Essays, among others made on ye Volatile Liquors put into the Exhausted Receiver, the Vial was set in a Goblet of Water, & it boiled with great Violence, a great deal of it evaporated, & the Water surrounding it was converted into Ice, occasioned by the Absorption of the sensible heat suddenly into latent heat, wch is necessary for the Conversion of Ether into Steams & from the

Analogy of the difference between the boiling point of Water under the Pressure of the Air & in Vacuo; the Ether shd. boil in Vacuo at 20° below nought or 52° below frost. It also produces a great degree of Cold by spontaneous Evaporation suspending the Thermometer & freely wetting the Bulb with Ether it can be cooled to a great degree & we can produce Ice in Water by wetting the outside of the Vial with Ether in the middle of Summer. Its Inflamms is very great, it takes fire even upon the approach of flame, & in pouring it out of one Vessel into an other it requires some attention, not to do it near a Candle as it is in danger of taking fire; & the Operation of Distillations must be performed in day light lest the Steams take fire. I shall pour about a Teaspoonful of it into a Cylindrical Vessel, & the whole of it is converted into Vapour, filling the Cavity of the Vessel & expelling the

the greater part of the Air it contains & upon opening the Vessel & inverting it towards the flame of a bit of Paper the qty of Steam takes fire as these Volatile & Inflam.le Substances do w.h we hear of as occurring in the Subterraneous Caverns.)

Another remarkable quality, w.h has been admired in Ether, is its Effect upon a Solution of Gold w.h will be mentioned when we come to that Metal. Sect. 74.th

Its Medicinal qualities deserve our Notice. 20 or 30 drops of it taken proves a powerful Antispasmodic. But its Effects, externally applied, are more striking. The Method is to put a few drops on the hollow of the hand, or to wet a piece of Cotton with it & instantly to apply it to the part of the body where we want it to produce its Effects, keeping it so close w.th our hand y.t it may have no Communication w.t the Air, it soon increases the heat of y.e Skin & produces the Sensation of burning; but

then heat gradually diminishes & soon goes off altogether, & it very often removes violent Pains or Spasms of the Rheumatic Kind. Toothach & Headach often yield to it when proceeding from some Affection of the part itself; when owing to something disturbing the Stomach, the Application to the head can do no Service. It acts by raising a heat in the Skin like that of Blisters & Sinapisms, & may be used to answer purposes similar to these for wc. Blisters & Sinapisms are used, it is a more ready Inflamer of the Skin, & the moment the hand is removed the Irritation & Redness go off.

In Mr. Quer you'll find a Theory to explain in what way it is produced, he supposes Spt. of Wine to consist of a subtile Oil blended with Water, & yt. the Vitriolic Acid acts by taking away the Water, so as to bring it to an oily State. But his Notion is not founded on facts, that ye Spt.

is a Compound of Oil, as using the Language of Chemists speaking of the Pr. of Infl. who imagined it to have the form of Oil, but it has no palpable form in its separate State, & many of the Phenomena of the Process cannot be explained upon this Supposition. The Vitriolic Acid unites as readily with the Pr. of Infl. as with the Water, so it is quite unfit for separating the Water so powerfully from the Inflamm.le Matter as to bring it into the State of an Oil.

With reg. to the Nitrous Acid, the Consequences of mixing it with Sp.t of Wine are among the most curious & striking in Chem. & they greatly illustrate the Power of this Acid over the Metals & its manner of acting upon them. I shall put a small q.y of this Acid into a Vessel & gradly add some Sp.t of Wine, it immedly raises a great heat & Ebullition, copious & deep coloured red fumes fly out of the Vessel, & these Phenomena are

repeated till at length the Acid is dissipated; the remaining Liquor has not the Odour nor other qualities of the nitrous Acid, the Glass becomes cooler, & the appearance of the red fumes ceases entirely, & the Ebullition comes to an end, the remainder rather resembles the Odour of the Acetous Acid, & the remaining Liquor has but little Insty, the Inflammable part of the Spt. of Wine flies off, so these red Vapours are the Nitrous Acid rendered Elastic & Volatile by the Spr. of Insty of the Spt. of Wine. If we put in the Spt. of Wine first & add the Nitrous Acid by degrees there is a Variety in the Appearance. The first additions of Acid are so diluted yt. they produce no Effect, but when a certain qty has been added ye same Appearances begin to take place.

Nitrous Acid may therefore be compared to the suffocating or sulphureous Vitriolic Acid, when it is thus brot. into an Elastic State of Vapours from wh. it is very difficult

to condense it. These Phænomena appear to throw light upon some of the most remarkable qualities of Acids upon the Metallic Substances. —— Tho' strong, it has sometimes very little appearance of strength being of a pale yellow colour, not tinging the Air in the Vial of an Orange colour as usual. Further, when the Vial is opened it does not emit such copious fumes, & when diluted with Water it produces no particular colour; but merely a dilution of its own yellow colour with some heat. In this State it may be called the more fixed Nitrous Acid, & the high red colour wch it usually has proceeds from a small qty of the Pr. of Inflly. It might receive it from the Vitriolic Acid employed in the decomposition of the Nitre, or it may proceed from foulness in the Nitre; or the Acid might receive it from the fire; for it is certain yt some Substances do receive this Principle from merely being exposed to heat

as well as to Light. Ende I've hit whon an Expert by w.ch I can immedly change this Acid so as to give it the appearance of the other; by introducing a small qty of Inflamle Substance, viz.t Spt. of Wine; but were we merely to put it in, so much of the Acid w.d be dissolved in Vapour & the sefred fumes produced; therefore we introduce it gradly by means of a tube w.ch is drawn into a very small bore at the lower Extremity, & introducing it to the bottom of the Acid I let down ye Spirit by taking away my finger from the upper part of the tube so as to let in the Air, at the same time cooling the Acid in Water to condense the Steams.

It has been discovered yt the Nitrous Acid can convert the Spt. of Wine into a subtile oily fluid or Æther; the Preparation of the Spiritus Nitri Dulcis led to this; When the Nitrous Acid is dropt into the Spt. of Wine, the first additions don't produce any violent effects,

Effects, till a certain q.ty of Acid has been put in, after this it boils violently, but stopping short of this & preserving the Liquor some time, it diffuses a fragrant Smell. The Existence of this Ether was not properly known till M.r Xavier communicated a Process for obtaining it, w.ch was simply to add a greater q.ty of the Acid than was ordered in our Dispensatories, to mix them cautiously in a strong bottle well corked, after w.ch the Ether rose to the top of the Liquor. But it is almost impossible to mix them in y.e proportion necessary, without being much annoyed with the fumes & exposed to the risque of the bottle bursting.

M.r Beaume has ascertained the just proportions w.ch afforded the greatest yield of Ether, & added a particular Process by w.ch any Accident is prevented. He puts ℥vj of Sp.t of Wine rectified into a strong bottle capable of containing a pound of Water, & adds ℥iv

of strong Spt. of Nitre, gives the Spt. of Wine a rapid circular Motion at the time the Acid is added, & allows the bottle to remain in cold Water that any heat may be taken away before the next addition is made; as soon as the whole of the Acid is put in the Cork is bound down with Leather & Pack-thread, & the Water is cooled by putting pieces of Ice into it; in 2 or 3 hours the Liquor becomes muddy from the Ether form^g thro' out the Liquor, w^h grad^ly rises to the surface to the Amo^t. of ℥iij in 24 hours, & of ℥iv in 7 or 8 days, & no more afterwards is produced; at the same time there is a great q^ty of Elastic Aerial Matter, w^h must be attended to in opening the Vessel, if we were to cut the String & draw the Cork in the ordinary manner the whole Mixture w^d be thrown into an Ebullition & an Elastic Fluid or Vapour burst out of the Vessel, so y^t we must pierce a hole thro' the Cork with a

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small Wire that the Elastic Matter may go off gradually; as soon as it has ceased the bottle is opened; & the Ether separated from the Acid by means of a funnel. This is a very good Process & succeeds very well, but requires much Care & Caution, & the Ether can't be preserved any time. If it is rectified by Distillation with an Alkaline Salt we may perhaps bring it into a State for keeping. But if immedy poured off from the Acid Liquor & corked up in a Vial, it generates a qty of aerial Matter wh blows out the Cork & the Ether evaporates.

For a considerable time before I learned this Process, I used to follow a diff! Method, wh is rather more simple & produces an Ether more free from yt troublesome quality of generating an Elastic fluid.

I take ℥ij of strong Nitrous Acid, Sect: 75th & ℥iij of Spt of Wine, I first put the Acid into the Vial, then pour in very slowly

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a q.ty of Water nearly equal in bulk to the Acid or somewhat less, that it may float as much as possible on the surface of that Acid, I next pour in Sp.t of Wine in the same slow & cautious manner, y.t it may float in its turn upon the surface of the Water. The Acid grad.ly rises up by attraction thro' the Water & is mixed with the Sp.t of Wine, & in proportion to the q.ty of the nitrous Acid the Ether is formed, & to render the Operation more secure we set the Vessel in cold Water, as the Acid rises up a gentle Ebullition is produced, & an elastic fluid generated w.ch gets thro the Glass Mosiper.

The Chemists were acquainted w.h these two Oily fluids long before they knew a Method of producing the same kind by means of the Muriatic Acid. Pott & others tried several Exper.ts for obtaining a product of this kind but did not succeed. It has but little Attraction for the Sp.r. of Inflly, & these

Æthers are produced by a Combination of yᵉ Acid with the Spᵗ of Wine. In the Nitrous Æther a great part of the Acid disappears, & oily fluids are produced upon other occasions by these Acids & Inflamᵇˡᵉ Substances.

But at length a Process was communicated to the Public in the Memoirs of yᵉ Academy of Sciences by the Marquiss de Courtevaux. In this Process the Muriatic Acid wᶜʰ is mixed with the Spᵗ of Wine, is combined with a Metallic Substance, to wᶜʰ it adheres very slightly, but forms a ponderous fluid wᶜʰ can be reduced to a stronger State & more free from Water, as from its Weight it is capable of receiving a considᵇˡᵉ degree of heat before it is converted into Vapour, the Air promotes its disposition to emit Vapours, but in close Vessels it requires a considᵇˡᵉ degree of heat to make it distill. In this Compᵈ: w. Tin it is called the Smoaking Liquor of Libavious. This is added to an equal Weight

of Sp.t of Wine, & the Liquor is distilled with a brisk heat, & a fluid is obtained; containing a q.ty of Muriatic Ether w.ch is capable of being separated from some Acids by distilling it with fixed Alkali: It has y.e same tenuity & Volatility as the two other Ethers, but has a particular Odour distinct from either.

M.r Woolf has since given a Method for obtaining a Muriatic Ether not by mixing y.e Acid with the Sp.t of Wine, but the Steams of both are made to mix together in the same Receiver. In one Retort he put a q.ty of Sp.t of Wine so heated that copious Steams issued from it, & in the other a q.ty of common Salt; in the upper part of the Retort there was a Perforation at w.ch a q.ty of the Vitriolic Acid could be poured in occasionally. The Necks of both were inserted into a Receiver having two Mouths with a Pipe in the upper part inserted into a Vial, & in the upper part a tube arose the Extremity of

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which descended & was plunged into ano-
ther Vessel containg Spt. of Wine. Fire was
applied to both the Retort & a qty of strong
Vitriolic Acid poured into the Retort with
the Salt, & the Elastic Steams of the two bo-
dies uniting, a part of them was con-
densed & descended into the Vial, while
another part went by the long tube. So he
obtained a Combination wh by Rectificati-
on afforded Muriatic Ether. But this Me-
thod is not so quick & is more troublesome
than the former. Besides, it has been
found yt even the Vegetable Acid with Spt.
of Wine can produce Ether & this shews yt
the Ether is not produced by any Separation
of the Water; because several of the Acids
don't shew a strong Attraction for ye Water,
& it is manifestly produced by a Combination of
the Acid & Spt. of Wine. The Process for ob-
taing it by means of the Vegetable Acid was
contrived by Count de Lauraguais. He

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took a Vegetable Acid in its strongest State; Viz. distilled Spt. of Verdigrease, wh. is a very strong acetous Acid. The Acid adhering to the Copper with sufficient force to admit the separating the whole of its Water; but not so strongly but that a certain degree of heat separates them, & it is a little below what destroys the Acid. So it is equal in Strength I believe to the Mineral Acids; tho' still it retains the same nature & produces the same Compounds. This mixt with an equal qty of Spt. of Wine & distilled on a brisk fire yields an Ether with a flavor of its own wh. is not so agreeable as that of the Mineral Ether.

The only other Acids are those of Tartar & the Sedative Salt, as also those of Spar & Phosphorus—

With reg. to the Acid of Tartar, no attempts have been made, & probably they wd. not succeed, ye Acid being a fixed substance wh. allow the

Spt.

Spirit of Wine to fly off without any Change.

The Sedative Salt mixes with the Spt. of Wine & communicates a green flame to it wn set on fire.

With regd. to the Acid of Spar it has a disposition to be combined with Spt. of Wine without forming any Siliceous Matter. From distilling a Powder is produced on the Surface having the qualities of the flinty Earth, but applying Spt. of Wine there is no such Production. The farther qualities of this Compd. have not yet been examined.

Of the Compd. Salts, some are soluble in Spt. of Wine, others not. Some are separable from Water by it, as a Solution of Tartar, Epsom Salt, Glaubers Salt, Vitriol &c. the Spt. uniting with the Water, but many of 'em can't be separated from Water in this way, but will dissolve in pure Spirit, as the Ammoniacal Salts, & those containg the Acetous Acid, particularly Regenerated Tartar, wh dissolves plentifully, & the Nitrous & Vegetable Ammoniacs

& the other Ammoniac more strongly.

Vitriolated Tartar, by long digestion, has the Acid formed into a qty of Ether & a qty of Volatile Sulphurs. Acid n̄ while an Alkali uniting with a part of the Spt produces a Vol: Alk: & some have a Vitriolic Ammoniac.

Of the Earthy Substances, none produce any remarkable Effects, nor any of the Inflammle Substances, except Phosphorus & Sulphur.

The Phosphorus may be dissolved by means of Spt. of Wine, when it acquires properties taken notice of by Mr Boyle.

Sulphur is most easily dissolved by Spt of Wine, when it is combined with an Alkali. Count de Lauraguais has shown a Process by wch they may be united without any Addition. If the Sulphur is put into the Spt. in Substance & digested it can't be dissolved. His Method is to apply heat to them in separate Retorts, & directs their Steams into ye same Receiver, whereby he obtained a qty of Sulphur

dissolved. This Method therefore, of applying bodies in the form of Steam, with a view to mixture, is a new way, & may prove a Source of new Discoveries.

These are the principal facts relative to Spt. of Wine wch deserve our attention.

Oils.

This division comprehends the Vegetable & Animal Oils, & the Inflamd. Substances in Animals & Vegetables of an oily Nature; & therefore includes not only what are comly called Oils, but also the solid parts of Animals & the Resins of Vegetables wch. are distinguishable by only a slight degree of fusibility.

These Inflamble Substances are not equal in Simplicity to Spt. of Wine; they contain a larger qty of Water, wch is the basis of most of them. but besides this, there is a certain Matter like ardent Spirit, & also a qty of Earth &

fixed Air. The presence of these Ingred^{ts} is demonstrated by Distillation & Inflam^{n}. All the oily substances repeatedly distilled are resolved into Water, a small q^{ty} of saline Matter & a Charcoal; so Olive Oil distilled in a Retort with a gentle heat, the Steams consist chiefly of Oil, but there is also a q^{ty} of Water holding a small portion of saline Matter dissolved. The Oil at first is thin, & grad^{ly} becomes thicker, till at the end there is a portion considerably thick, & a certain q^{ty} of Matter remains form^{g} a Charcoal.

If we take the Oil, thus distilled, & put it into a clean Retort, we obtain the same Products, we get a little more Water & a saline Matter together with a small portion of Charcoal, & we get these Products without any end to the Repetition; after a certain n^{o} of times the remain^{g} Oil has a great tenuity & Volatility, & the Repetition does not produce such Effects, but still there is a little Charcoal, & a

portion of the Oil reduced to Water, & the Charcoal is of the same nature, containg a small por-tion of Earth, Salt, & fixed Air, into wh it is chiefly resolved when set on fire.

These Principles can also be demonstrated by setting the Oil on fire, & it is best done when burnt with a small flame, when the Consumption & Dissipation are more compleat. We suspend a proper Apparatus to condense a watery humidity, & a great deal may be col-lected, fully equal in Weight & bulk to ye Oil employed. The other Principles become less evident in this way; the saline Matter, whe-ther a Vol: Alk: or acetous Acid, or a Mixture of the two, in passing thro' the external parts of the flame, is destroyed or dissipated; but the Earth is still discoverable as in the using a Lamp furnace tho' the flame is very small & no Appearance of Soot, the bottom of the Iron Pot is covered with a small qty of whi-tish Earth, wh is plainly the Ashes of the Oil ad-

rising to the Surface of the Metal,

So by both ways we discover that the princ-
ipal Ingred.t is Water, & y.t they contain a small
portion of Earth, w.c is found in all Oils, &
some saline Matter of the most volatile
kind; in w.c respect the Oils are a little
more compounded than Sp.t of Wine,

They are also distinguished by a great q.ty
of the Pr. of Infl.y. This may be inferred from many
Phenomena, partic.ly the great Light & heat they give
in burning in conseq.ce of the Pr. of Infl.y being more
closely combined w.t the basis of the Oil, & more
clogged with the other Principle, so requires
more heat to its Separation, When it does
take fire the Inflam.le Matter is less perfectly
consumed unless the Circumstances are
partic.ly favorable to its compleat Consumption,
from this Circumstance arises Soot, it is
a part of the oily Vapours, w.c ~~once~~ made a
part of the flame, was scorched & burnt to a
Sort of Charcoal, but has escaped a total Decom-
position by the Inflam.n

We observed that Soot is produced from all Oils burnt with a large flame. This Substance is an Article of the Materia Medica, but the Soot used in Medicine is from Vegetable fuel, w.ch may differ from the Soot of Oil. It is composed partly of this oily Vapour of the Vegetable Substances w.ch have undergone an incompleat Inflam.n & partly of Matters expelled by the heat before they take fire. While a piece of Wood is burning on one side a q.ty of Water is expelled from the other, issuing out in the form of Steam, & these Vapours mixing themselves with the Soot render it a very Comp.d Substance containing all y.e Principles w.ch are capable of being separated from Vegetable Substances by heat in close Vessels. These are principally a Vol. Alk. & an acetous Acid w.ch form a sort of Ammon.l Salt w.ch abounds in the Soot. Some alledge y.t there is also a small q.ty of fixed Alk, w.ch is volatilized by a strong fire. Sect: 76.th

These remarks belong to the oily Substances in general — We next proceed to treat of the Oils more particularly.

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They may be distinguished into Aromatic, Unctuous & Empyreumatic. These last are Oils changed by Distillation, or produced from bodies by heat, wh did not contained a formed Oil before the heat was applied.

The Aromatic Oils affect the tongue wt more or less Sensation of Taste & sometimes wt great Pungency. They all have more or less Sensation of Odour; in general it is very strong, in most agreeable, in others disagreeable; & lastly when we touch them between ye fingers they've neither Smoothness, Slipperiness nor Unctuosity.

The Unctuous Oils when uncombined are perfectly bland, they make no sensible Impression on the tongue, except one, wh is a certain Smoothness & blandness, resembling no other whatever, & wh we cant name. They are perfectly free of Smell. Between the fingers they feel soft, greasy & slippery; so are employed to diminish the Friction of hard Bodies upon one another. The

Empyreumatic resemble ye Aromatic very much. There

there is no other distinction but by having recourse to their Origin — We begin with the

Aromatic Oils.

These are chiefly found in Vegetables, there are a few oily Principles, belonging to this Class, found in Animals, but such Examples are rare. In Vegetables a great Variety is found, all Vegetables in wc. we can distinguish any sensible Odour contain an oily Principle of this kind, & as the no. of Vegetables is very great, we have a great no. of these Oils, & being the most active & useful Principle of their Composition, they are called Essential Oils. These differ from one another in several respects, but many of 'em have not been found applicable to useful purposes, & others can't be extracted, but at an Expence exceeding the Value wc. can be set upon them, as ye Oil of Roses, wc. sells at an extraordinary Price, even in the warm Climates where the Roses contain a great quantity of it.

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The other obvious qualities, besides the Odour, are these; some of them are very fluid, light, subtile & volatile; others are heavier, requiring more heat to convert them into Vapour. Most of 'em affect the tongue with the Sensation of a sharp, acrid, burning taste; & some are milder. It is difficult to give any gen.l Rules with reg.d to these qualities, the only one is w.t reg.d to their Weight; in the colder Latitudes they are lighter than Water, but in the hot they are so heavy y.t they sink in this fluid. But even this Rule is far from being just, for y.e same Oil appears in diff.t States in this respect, as in the distilling Cinnamon, w.ch if distilled w.t a gentle heat floats on Water, but if the distillation is conducted w.t a stronger heat it sinks; And I'm inclined to think y.t this Rule has been drawn from the dry Spices from y.e East & West Indies, in w.ch the Oil is thicker from the Evaporation of the thinner parts. It is difficult to preserve them long in Perfection, the only way is to keep them in Vessels with Glass Stoppers carefully

bound, set in a cool place & seldom opened. They be-
come less fragrant, less fluid, & of a darker Colour,
wc Changes happen more quickly when they are
exposed to the Air; so yt depreciation they suffer
proceeds from yt Exhalation of a subtle & volatile
Principle upon wc their tenuity & Odour princi-
pally depends. This is confirmed by the nature of
the Operation for restoring some part of yt Oil to a
State of Perfection, wc is to distill part of it mixed
wt Water in a gentle heat. They are in genl very
volatile, & in the heat of boiling Water they emit
visible Steams & evaporate copiously. This Vola-
tility is gradly impaired by keeping, as in the
Oil of Turpentine wc suffers it very quickly. You
will see how easily they are converted into Vapour,
When I put a drop or two of the Oil of Sassafras on
a piece of Paper & hold it at a considle distance
over a Candle it totally evaporates without leav-
ing an oily Stain upon the Paper. This Property
they shew most remarkably when fresh. When
old & ill kept it is not so easy to separate them
entirely —— Distilled with Water we obtain

a portion of the Oil much improved; while what remains is thicker, darker & less odorous; & we can increase the Volatility beyond what it was at first. The diminution of the Oil is most apparent without the addition of Water each time a small portion of the Water separates & a thick resinous Matter remains, w^ch becomes Charcoal, & by degrees the whole of the Oil is decomposed, & at the same time we discover a small q^ty of a saline Principle, comm^ly of the acetous kind, & a q^ty of fixed Air w^ch composes the Charcoal.

Set on fire, they are more easily decomposed, & are more inflam^ble than the Unctuous Oils. It is with the Oil of Turpentine y^t the Wicks of Candles are prepared for lighting quickly.

These are the qualities of these Oils with respect to heat ——— Next with resp. to Mixture;

They unite with Water, when shaken with a large q^ty of Water it dissolves a portion of the odorous & more volatile part, & receives a degree of pungent taste & Odour of the Oil, & what remains has lost a part of these qualities. However

this Solution of Oil contains but a small portion of it, & the Water has some degree of whitish Appearance. —

Both the Alkalies & Acids have been combined with these Oils. The fixed Alk. unites with difficulty & imperfectly, the process has been much talked of under the name of Starkey's Soap, by Mr Lucer &c. The Operation is uncertain, the Soap is produced by combing the Oil of Turpentine with a fixed Alk. but it is impossible to unite them together. Beaume has made a no. of Exper.ts to this Effect. He alledges yt. the Oil wch has suffered some deprivation by long keeping, is best for this purpose, & advises to grind them on a Marble yt. the more odorous part may evaporate, & in proportion to this it will unite. After all these pains I don't know what use it is to answer, for the purpose of Medicine we have no reason to expect any Virtue wch is not possessed by the 2 Ingredients. They are both Diuretics, & they may act in Doses one after another as well as when intimately

combined. Combinations of these with ye Vol. Alk. are made for the purposes of Pharmacy, to produce grateful, stimulating, cordial Medicines, as the Spt. Salin. Aromat: &c. of the Dispensatories.

With regd. to the Acids, as they have such a violent Attraction for the Pr. of Inflty they act violently on the Oils, & we find reason to conclude yt this Principle is not so strongly combined with these Oils as with the Unctuous Oils, wc. don't act so readily upon Acids, & are not so easily set on fire.

The Vitriolic Acid forms with the Oils a black Matter like Tar, emitting suffocating Vapours, having an Odour like the Sulphureous Vapours. you saw a Product made by adding some Vitriolic Acid to ye Oil of Turpentine, wc. immedy threw out copious Vapors.

The Nitrous Acid acts with more Violence, & in a certain Proportion it bursts out into flame in all, the Mixture flies up into a black Charcoal, the Oil being soon had by the flame; When we add to the Nitrous Acid a small qty of ye Vitriolic Acid the Action of the Nitrous Acid upon ye Oil is considy increased.

The Muriatic Acid acts with less violence, some of it I also mixed with the Oil of Turpentine, & it immedly thickened its Consistence, & darkened its Colour. And from other Expts. we find yt the Acid has much less activity with respect to the Inflamle Substances. — Such is the Relation of these Oils to the Saline Substances, the Alkalies & Acids.

As for the neutral Salts, none of these act upon them, the Acid & Alk. being both too much neutralized to act upon the Oil — Neither do any of the Earths produce any Effect upon them.

Of the Inflamle Substances, the Oil of Cloves produces a Liquid with the Phosphorus, wh. emits a luminous Vapour, & when rub'd upon ye Skin or the hand or face it makes them appear luminous — They also dissolve Sulphur reduced to a fine Powder, & the Oil heated, the Solution is of a red Colour & acquires a thicker Consistence. It is called Balsam of Sulphur, & there are many such made.

The relation of Spt. of Wine to these Oils

deserves a little of our Attention. It dissolves
most of them with Ease & in consid^ble. q^ty, as when
I drop a little of the Oil of Sassafras into the
Sp^t. of Wine it immed^ly unites with it in the
most intimate manner, constituting a fluid
perfectly transparent & homogeneous. This is y^e
Case with reg^d. to all the Aromatic Oils without
Exceptions, only some can be dissolved in greater
q^ty by the Sp^t. of Wine; there are some with w^ch
we can't say the Sp^t. of Wine will be saturated
but it has a greater disposition to dissolve those
w^ch are thicker & resinous, than those w^ch are
more fluid, subtile & volatile. M^r Quer accounts
for this, on the Supposition y^t. the Sp^t. dissolves these
by acting upon a saline Principle, & y^t. the
more viscid & heavier Oils contain a greater
q^ty of this saline Principle; but I don't think y^t
this Acc^t. of the Matter is satisfactory.

The Oil is easily separated again more or less
perfectly by the addition of Water; the Muriatic
Acid becomes white like Milk, the Sp^t. leaving
the Oil to unite with the Water w^ch appearing
in

in the form of minute Globules thro' the fluid, give it that appearance.

A Compound of the Oil with Spt. of Wine may be decompounded by Distillation, the Spt. never fails to carry up the most subtile & volatile part of the Oil, y^{t}. part w^{ch}. is most fragrant; hence the most delicate Preparations of y^{e} Aromatic Oils are produced by distilling the Oils themselves with Spt. of Wine, or the Substances containing them. When they are distilled with Water the heat of it dissolves & elevates more of the Oil, while the heat of the Spt. of Wine elevates only the most fragrant part.

The fine scented Waters are prepared by distilling the Substances containg these Oils with highly rectified Spt. of Wine. Beaume directs to rectify these by distilling them in a gentle heat.

These Oils of Vegetables are secreted Juices, lodged in particular Vessels, sometimes in the Bark, as in Cinnamon; sometimes in the

verts the Oil into Vapours, wh. are carried over more copiously by these of the Water than they wd. otherwise rise of themselves. So as soon as the Water is condensed it becomes milky, the Oil condensing along with it in minute drops, collected into larger & rise to the surface or fall to the bottom. This Operation is the only means of applying heat to Vegetables in order to extract the oils of this kind; for their Volatility is but moderate, requiring the full heat of boiling Water to convert them into Vapours, & we cant apply yt. heat to all the parts of a Vegetable Substance in any other way than by immersing it into boiling Water. If it is put by itself into the Still, before the upper part is of a due degree of heat the under will be burnt to a Charcoal & all the other parts confounded; but by the Water the heat is raised to the degree necessary to convert the Oil into Vapours over the whole of the Substance at the same time, & these Vapours wh. wd. ascend more difficultly are pushed over

more quickly by the ascending Vapour of ye Water: It is true yt a portion of the Oil is consequently dissolved by the Water, wch is impossible to recover again; but when the Operation is done for the Sake of the Oil, the same Water can be employed in the next distillation, & as the Water is capable of receiving only a certain qty of the Oil, it will dissolve none of the Oil of the 2d Parcel.

From some particular Vegetable Substances these Oils can be obtained in a mechanical manner, as from the Lemon & Orange, merely by squeezing the Rhind to burst the Cells in wch the Oil is contained; or we rub ye Rhind upon Loaf Sugar, when the roughness of it breaks open the Cells, & the Pores of it imbibe the Oil; & the Sugar thus moistened may be scraped off, & the Operation continued till a proper qty of Oil is obtained mingled with the Sugar, & this may be very useful on many Occasions, as the Sugar is not an unfit Ingredient to be added to the Mixtures in wc. these Oils are comy used.

Such is the nature of the Aromatic Oils. } Sect: 77th.
But there is one w.^ch differs from this gen.^l }
Succ.^t & possesses Properties w.^ch are always
taken notice of by Chemists as peculiar.

This is Camphor, w.^ch is plainly an Aromatic Oil from the greatest n.^o of its qualities, & also from its Origin — It is produced from a Sort of Laurel. It is deposited in particular Vessels as the Aromatic Oils are, & it is extracted in the same manner, by exposing it to the heat of Boiling Water — It has a strong Odour & a pungent warm taste like the Aromatic Oils. It is also highly Inflam.^ble Further, it is easily soluble in Sp.^t of Wine, & separates again by Water.

It is easily distinguished by having a great degree of Solubility, & heat totally evaporates it before it rises to the degree necessary to its fusion, but when made to undergo more heat in close Vessels it becomes an oily fluid, but where the Steams are not forcibly confined they rise & condense in the colder parts of the Vessel in a solid form, as it is capable of Sublimation & not of Distillation —

Its relation to Acids is still more particular, some of these act with violence, ~~but~~ on the Aromatic Oils, as the Vitriolic & Nitrous, but when applied to Camphor they dissolve it without any Violence or decomposition; & the Nitrous composes with it what may be called a Sort of Ether. When the strong Acid is used it dissolves a consid^{ble} q^{ty} & assumes a deeper Colour than y^{t} of the nitrous Acid in its pure State. Upon adding a little Water we have y^{e} Acid & Camphor in the form of an Oil above, & below a watery Liquor of a greenish Colour from a small q^{ty} of the Acid. This sudden Production seems to be similar to y^{e} Production of the Nitrous Ether, but this fluid is only such in Appearance; upon adding more Water y^{e} Acid & Camphor are separated from one another, as by dropping a q^{ty} of the Mixture into Water the Water attracts the Acid, & as y^{e} Solution descends down the Camphor assumes a solid form & produces long films w^{ch} descend down thro' the Water, & upon examining this we find it to be pure Camphor quite unchanged — &c.

So this is a singular Circumstance in the nature of Camphor considered as an Aromatic Oil, that it sh.d unite with an Acid w.ch acts with such Violence upon the Pr. of Infl.y with-out suffering any sensible Change. This w.d seem to shew y.t the Pr. of Infl.y is here more intimately combined with the other Principles than in the other Aromatic Oils. And another Circum-stance agreeing to that is this, tho' we repeatedly apply heat to convert it into Vapour it does not undergo any decomposition; the heat converts it totally into Vapour without changing any part into Water & Charcoal.

The action of the Vitriolic Acid upon Camphor is not so remarkable. It forms a thick Solution from w.ch the Camphor is easily recovered by dropping it into Water, but it does not form an oily like fluid.

There is only one Species of this to be found in the Shops, but several Species may be obtained from different Vegetables w.ch differ only in the particular Odour & flavor they exhale. Newman

obtained one from the Oil of common Thyme, when it is kept some time little transparent Crystals form, w.ch taken out prove a Camphor.)

Under the Division of Aromatic Oils we comprehend the

Balsams & Resins,

as nearly resembling them. They are found in various Vegetables, & are secreted Juices, deposited in particular Vessels of the Plants.

In general, when applied to the tongue they produce the Sensation of taste with more or less pungency & Heat. They are all more or less Inflam.ble but produce more Coal & Carbonaceous Matter; & from these Exp.ts they seem to contain a large Proportion of Earth.

Diffused in Water they impart to it their taste & Colour more or less strongly, but don't dissolve in any considerable quantity.

Acids dissolve them with great Violence & Rapidity, with the Production of Heat & even of flame. They are dissolved

with Care by Distilling, & separated again by Water — In all these particulars they resemble the Aromatic Oils.

The chief distinctions is in the degree of fluidity & Volatility. Many are com[ly] solid & very hard. The greatest part of the Balsams have a sensible degree of fluidity. Some of them are nearly as fluid as some of the Essential Oils, while the Resins are solid & brittle in the ordinary temperature of y^e Air, with Heat they melt into an oily fluid not distinguishable from what is called Balsam. Some are brown, some are reddish, some more transparent, & have various degrees of fluidity. Indeed the same individual Balsam varies in its Consistence by degrees, if long kept, tho' pains are taken to confine the Volatile parts, they suffer a dissipation of their more volatile Principles. Here is a Canada Balsam, w^ch was little less fluid than the Oil of Cloves, but is now so viscid y^t. the Motion of it is

very slow upon inclining the Glass.

These Substances are in gen.^l more soluble in Sp.^t of Wine, & are more disposed to unite with alkaline Salts, & common Resin is employed in the Composition of hard Soap.

From the Effects of Heat upon them we still discover more Circumstances in w.^ch they differ from the Oils. Boiled in Water they are in part converted into Vapour, & disperse their Odour all around. If this Vapour is condensed it forms a perfectly fluid fragrant volatile Aromatic Oil, while the remaining Matter is less Odorous than the Balsam was at first; it is heavier & is commonly found to be changed into a perfect Resin, & brittle in the ordinary heat of the Air. If these are submitted to Inflamm.^n we obtain a small q.^ty of Aromatic Oil; but as the greatest part has little Volatility the heat scorches & changes the Arrangement of their Particles, forces off oily Vapours, called Empyreuma-

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tic, & some Water containg the acetous Acid; & the black Coal remaing when burnt to Ashes, leaves a large proportion of Earthy Matter.

A great Variety of Vegetables contain Balsams & Resins; & some of them are more soluble in Sp.t of Wine, some are difficultly soluble in it; & hence the different kinds of them. According to their diff.t degrees of transparency, want of Colour, &c they prove useful in a variety of Arts. But the gen.l Character is applicable to them all except Benzoin. In all parts of nature the Productions are so diversified y.t it is impossible to give Characters w.h will answer every particular. So after considering the greatest part of bodies w.h are similar to one another, under one head, we then treat of the rest, w.h also in most of their Characters belong to it.

Benzoin undoubtedly belongs to this division of oily bodies. It is pro-

duced from a particular Vegetable in like manner as the other Balsams are; & at first has a considerable degree of fluidity, but by keeping becomes solid & brittle, & has more of the Consistence of a Resin than a Balsam, It is genly mixt with Straw, bits of Wood, & Vegetable Substances of diffᵗ. kinds.

The Singularity of it is its containg a Volatile Substance separable from the Benzoin in like manner as Aromatic Oil, but the nature of wᶜʰ is considˡʸ different. If the Benzoin is put into a shallow Earthen Vessel, & a Cone of Earthen Ware or even Paper is fitted to it, a moderate heat being applied, the Benzoin melts & exhales a Volatile Matter wᶜʰ diffuses a very strong Odour; the greatest part of it continues on the Cone & composes the Flowers of Benzoin, wᶜʰ are thus condensed into minute Crystals resembling snow.

When we examine the Chemical Properties of these Flowers, they have a middle rank be-

tween the Aromatic Oils & saline Substances, they are soluble in Water by heat, & can be extracted from Benzoin by warm Water, they are also soluble in Sp.t of Wine & the Solution have some degree of Acid taste, they melt upon a hot Iron & evaporate like the Aromatic Oils, diffusing an Odour, w.c is considered as a Perfume, & the Benzoin is employed in the Composition of many Perfumes.

Several facts with respect to the Aromatic Oils give reason to suspect y.t they contain a q.ty of the Acetous Acid in their Composition, so here it is very redundant, w.c gives the Comp.d more qualities of a saline Substance than an oily one.

The balsamic & resinous Substances are in gen.l secreted Juices & are found in particular parts of the Vegetable. The Process by w.c they are obtained is not the same as y.t employ- for the Oils. The gen.l manner in w.c they are obtained is by cutting the Vegetable in

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different places so as to occasion it Juice to be shed by bleeding, & it even sheds spontaneously in consequence of an over fulness of the Vessels occasioning them to burst. These Juices issue out as fluid as an Aromatic Oil, but issuing out slowly they suffer an Evaporation of their more subtile parts, & gradly increase in thickness & Consistency till they acquire the Consistence of a Balsam, or the Solidity of a Resin.

Many of these Substances are applied to useful purposes in Arts as well as in Medicine. Many of them, of great transparency & hardness, when dissolved in Spt of Wine compose Varnishes, wch being spread on Wood the Resin remains while the fluid wch held it dissolved, evaporates, so gives the Substance a Gloss & cuts off the Communication with the Air.

Another Production of Vegetables of ye same Origin, but of a totally diffnt nature, which
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ought not to be mentioned here, but to take notice of a Confusion of Names, is the

Gums, This name is applied to Camphire, &c. but improperly; for Gum is a Substce different in many of its qualities. It dissolves in Water, not in Spt. of Wine, & has no more Infly than any other uninflamable Substance. Thus Gum Arabic thrown into the fire like a piece of Wood or other Vegetable Matter — Another Sett to wc. the term Gum is improperly applied, is the Gum Resins, wc. are a mixture of Gum & oily Matter, as Ammoniac, Galbanum, Assafoetida, &c. Spt. of Wine applied to these dissolve the Resinous part & leaves the gummy part, while Water acts chiefly on the Gum. We shal speak of these when we treat of the Vegetable Substances, the Gum being merely a Vegetable Subsce wc. can't be properly referred to any of the 5 Classes of the Objects of Chemy,

Having now done with the Aromatic Oils, we proceed to consider the

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Unctuous, or

Expressed Oils, with which I include the solid fat of Animals, & there are even Vegetables w^{ch} contain these Oils in a solid form.

The most perfect are mild, free of taste & Smell, & feel unctuous & greasy between the fingers. Most of them are sluggish & thick compared with the Aromatic. They are lighter than Water, & less Volatile than the Aromatic Oils, don't so readily suffer y^e same Change when exposed to the Air; but if heat be applied while exposed, as the heat of Summer, they give an offensive Smell, acquire a thicker Consistence, a great degree of Acrimony, irritate the nervous System with much Violence, & I don't know any Substance more ready to produce noxious Effects when taken into the body than these rancid Oils.

The nature of this Composition has not yet been explained. I believe it depends upon

a beginning Resolution of the Oil, it generates an elastic Inflam.ble Matter in consid.ble q.ty in the Manufactories in w.ch large bellows are used for melting Iron, these are sometimes burst by the Inflam.n of this sort of Vapours communicating with the fire; the reason of this was not understood, & the only expedient to prevent the mischief was to have some holes in the under part of the bellows w.ch were occasionally shut when the bellows were used. But in pointing out the Suspicion they cut off the Communication between the fire & bellows by stopping the pipe. It was undoubtedly occasioned by an Elastic inflam.ble Air generated from the rancid Oil on the Leather of the bottom, w.ch mixt w.t the Air in y.e bellows in such q.ty as at last to render it inflam.ble

We find a great difference in their disposition to be affected by heat, they are not near so Inflam.ble as y.e Aromatic Oils & these have not the least degree of Volatility in the heat of boiling

Water or in some degree of heat above that. Most of them contain a little humidity & a mucilaginous Matter wch produces a Crackling & boiling, but this is soon over, as the heat increases it emits Steams acrid & offensive to the Eyes & Throats from their containg a small qty of Saline Matter, probably of the Acetous kind, along with a portion of ye Oil volatilized & rendered acrid by ye heat, the remainder is darker & higher coloured, the Steams are thicker & at length break out into flame; now Lead & Tin melt in it, & it approaches to the heat of boiling Mercury, to 600° of Farenheit. So you'll understand ye danger attending the approach of Water to boiling Oil. Some Artists have occasion to boil Linseed Oil, as for painting, but it must be done in the external Air, from ye risque of the Oil boiling over & setting ye house on fire, but at the same time they must be attentive to the Weather, ye it be clear, as the smallest drop of

Water falling into the Oil w^d. make it boil over with the greatest Violence. The Water being a heavier fluid is disposed to sink, but immy receiving such a degree of heat is converted into Steam with a Violence similar to the firing of Gunpowder, so is quickly thrown out of y^e Vessel.

When the Oil is heated to the degree I speak of, so as to emit copious fumes, we obtain some Water, gen^ly a small q^ty of Acid, sometimes some Vol. Alk. if the Oil is of the Animal kind, but the most part rises in the form of Oil scorched by the heat & becomes an Empyreumatic Oil.

We are next to take notice of the Effects of mixing them w^t. other bodies, w^c. differ remarkably from those of other Oils. Sect: 70.
In mixing them with Water we find a differ^ce between these & the Aromatic. The Aromatic are dissolved in small q^ty in Water, communicate their Odour, Pungency & particul^r. taste to it, y^e Water acting chiefly on the more soluble & active part of the Oil, but nothing of y^t kind

happens with respect to the Unctuous Oil. Suppo-
sing y^t a part of this Oil did mix it w^d. not be
readily discovered by the taste; but other
Exp^ts w^d. shew y^t they have not the least dis-
position to dissolve in Water, or yet in Sp^t. of Wine
perhaps from its having Water for its basis.

With respect to the Salts, they can be inti-
mately combined w^t. the Alkalies. With the
fixed Alkali, rendered Caustic with Lime, they
compose common Soap. The Importance of this
Comp^d. is well known, it derives its Solubility
& detergency from the Caustic Alk: The Oil
is necessary in order to moderate the Sharp-
ness & activity of the Alk: & to give a Slipper-
iness to the Cloaths, otherwise it w^d. injure
them, & from the Caustic Alk: adhering to
the Cloaths it w^d. be impossible to handle them,
& as mechanical force is one of the means of
extracting the foul Matters, it w^d. injure
the Cloaths greatly if they were not rendered
slippery & the friction diminished; So in

the Process of Bleaching, where the Cloth is exposed to violent friction; it answers the purpose. Soap is also soluble in Spt. of Wine, & in a Mixture of Spt. of Wine & Water more than in either separately. Heat increases the dissolving power of these Menstrua, & Cold diminishes it; if too much is dissolved by heat y^e Superfluity concretes into threads or a Jelly, in proportion to the qty, but this Jelly has a sort of fibrous Structure & contains in its Pores a qty of liquid Matter. Soap dissolved in Spt. of Wine has a disposition to concrete into fibres, & the Spt. acts upon the Soap in Conseqce of its Attraction for the Oil as well as for the Alkali. For when we decompose y^e Soap so as to have the Oil pure, it will dissolve in Ardent Spirits, it has undergone some Change w^{ch} gives it this quality. So, we can readily separate the Oil from the Alkali by means of Acids w^{ch} immedly unites with the Alkali. I pour a

q^ty of warm Water upon a q^ty of scraped Castile Soap, & by a little Agitation we soon obtain a perfect Dissolution, only there is some reddish Earthy Matter or Calx of Iron I believe, w^ch renders the Solution turbid.

Upon adding an Acid it immedly becomes white & opaque, & the Oil rising to the Surface carries with it that reddish Matter in the form of a coagulated Cake, a small q^ty of the Acid adhering disposes it to congeal in the Cold, but dissolving it in Sp^t. of Wine & adding more Alkali we can obtain a perfectly fluid Oil.

This Effect of Acids has led to y^e knowledge of the Cause of <u>hardness in Waters</u> with respect to Soap. The meaning of this term is this, when Water renders y^e Surface of y^e Soap greasy, & when it is necessary to agitate the Soap long before it forms a Lather with it & when by this long Agitation we obtain a Dissolution the Water throws up a greasy Scum, con-

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consisting of a small part of the Oil decomposed by an Acid in the Water. Such Waters are rarely found to contain a pure or separate Acide, but combined with some Substance not adhering so strongly, as the Calcarious Earth, the Earth of Magnesia, of Alum, &c. in the several Metals in wc. the Acide is so little fettered, that it is as ready to act as if it it was pure, so it prevents the Water from readily dissolving the Soap, till by the foresaid Dissolution a small qty of the Acid is neutralized, after wc. it will dissolve the Soap as well as other pure Water. In Mr. Quers' Chem. you'll find some of the neutral Salts blamed, but he has corrected it in the Diction: Chem: He was led into it from the Notion that common Salt made Water hard, & as we use it, it will render it hard, occasioning it to decompose Soap; but this proceeds from a Magnesia Salt mixed with it, there is a small portion

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of Epsom Salt, but when the common Salt is crystalized over again in that pure State it does not render it hard in the least. This quality of Water often proves inconvenient, as there are many Manufactories in wh. it is necessary to employ large quant. of Soap dissolved in Water, so it is of great consequence to have Water as soft as possible to prevent a Waste of Soap, as in bleaching, &c.

Therefore, it is of Conseq.e to learn how to discover hard Water, & to find out a Cure. Different Methods have been proposed, but there is no occasion for many new Chemical trials, the trial with Soap is as accurate & nice a one as is necessary, or dropping in a Solution of fixed alkali; if there is any such Comp.d it renders the Water muddy, tho' unless there be a certain q.ty the muddiness will not be observable, tho' the Water is hard with

regards to Soap; so the trial with a bit of Soap is sufficiently nice. With reg.^d to y^e Cure, there is no doubt y.^t the Addition of an alkaline Salt will remove this bad quality; but it is plain y.^t this Remedy can't be put in Practice at a moderate Expence; so it is eligible to chuse a Water naturally soft. This Method of softening Water is employed on particular occasions, as in Cookery, a small q^ty of Alkali added makes the Water boil Vegetable Substances more quickly & tender, & at the same time preserves their Colour in greater perfection.

In mixture with the diff.^t Acids, the Oils of this Division don't shew such remarkable Effects as the Aromatic Oils do. The Acids don't act with such Violence on them, the Pr. of Infl.^y is more fettered & closely combined w.^t the other Materials.

With the Vitriolic Acids they form a

thick Mixture appearing quite homogeneous, there is some degree of heat produced & after some time Vapours of a Sulphureous kind come from the Mixture. The Nitrous acts more violently, with a considerable degree of Effervescence & heat, forming a Mass having the Solidity of Pomatum.

These Combinations, having many of the qualities of common Soap, prove soluble in Water, if the Water is added gradly, the Acid retaining a great degree of Attraction for Water, tho' it does not part with y^e Oil, & it retains some degree of its acidity, but we can't readily decompose it upon adding an Alk; the oil does not immedy separate; there is an odd kind of Compnd of the Oil, Acid, & Alkali, & a small portion of the fixed Alkali is changed into the Vol: Alk: as appears when we dilute the Compd. wt Water & add more fixed Alk; the Pr. of Infly converting a portion of it into Vol: Alkali.

None of the other Acids have any remarkable Effects upon these Oils; & the Comp.d Salts have the Acids & Alkalies too strongly combined to have any powers over these Oils.

None of the Earthy Substances have any Effect except Lime in the State of Lime Water, forming a Mixture or Comp.d resembling Soap. A Mixture of this kind with Lintseed Oil is found to be a useful Application to recent Burns. I can't pretend to explain its Action, but probably a useful purpose is to defend ye Skin from ye Action of the Air, wc proves hurtful by drying ye part too much, whereby the Cuticle is wanting, & it is only the watery part wc evaporates.

With reg.d to the Inflamm.le Substances, these Oils dissolve the Phosphorus of Urine, & some of them form luminous Liquids as some of the Aromatic Oils do. They also dissolve Sulphur, we put the Oil

into an Iron Vessel, adding 1/8 or 1/4 part of the Weight of Sulphure, the Oil is heated till the Sulphure melts, it communicates a darker Colour to it. If 1/4 part is dissolved, it forms a gelatinous Mass; if only 1/8, it is of the Consistence of a Balsam, so is called the Balsam of Sulphure, & is Ordered in the Dispen.y under y^e Name. They can't be made to dissolve Charcoal. And they don't mix with Sp^t. of Wine.

So far the Acco.^t is applicable to the whole.

But we must mention a few particular qualities by w^ch some of the Species are distinguished.

Some shew a little Affinity w.^t the Aromatic, containg a Volatile Principle, the presence of w^ch is necessary to their fluidity, & as it evaporates y^e Oil becomes solid, y^e upper part next the Air having a thick film formed upon it; & when these Oils are spread upon the Surface of any body, as Wood, they acquire a particular Consistence & form a thin Covering of a tough Varnish. Such Oils resemble them in uniting

with Acids with greater Violence than the rest of the Unctuous Oils, Some of 'em can be inflamed by means of the Nitrous Acid.

Spermaceti, Bees Wax, &c. are distinguished by some particulars.

Spermaceti is an Animal Fat, & bears a great resemblance to the common fat, it is perfectly mild & insipid, it is indissoluble in Water, it has a consid^le. degree of Solidity, & has not the greasy softness of the other fats, nor does it leave a greasy Stain upon Cloths, but when cold can be rub'd off. It melts in a heat below boiling Water, & it congeals as Water congeals into Ice, without passing thro' any intermediate state of softness, forming a white & semitransparent Mass like Alabaster, & of a foliated Structure like Talk.

It is mixt w^t. the fat of a partic^r. Species of Whale, it is fluid in the Animal, but congeals w^n exposed to y^e cold Air. It is separated from a q^ty of fluid Oil, mixed with it, by Colature, by putting the Matter into bags, when y^e fluid Oil is

drained & squeezed from it by violent pressure; & y^e Spermaceti remains in the form of little transparent Scales. It is then melted w^t. a small q^ty of Caustic Alk: w^c unites with the remaining Oil, & changes it into a Soap while y^e Spermaceti is not disposed to unite with the Alk: in the least.

Bees Wax differs in having a greater degree of Solidity & forming a mild Empyreumatic Oil when distilled in a Retort y^e greatest part arising in an oily form, some in the form of a liquid Oil, y^e greatest part having some degree of Solidity, so y^e whole forms a Mass called the Butter of Wax, w^c has a less offensive Smell than most of the Empyreumatic Oils. It is also distinguished by its Origin; it is collected by y^e Bees from the Staminal Dust of Flowers, When these are examined they don't discover the qualities of Wax but the Animal swallows what it collects, & it undergoes some Change in its body.

Lac is a Substance of similar Origin; it is a matter employed by an Insect of the Ant kind;

kinds, to build Receptacles for its young, & is probably collected from resinous Trees & Shrubs. It is imported from the East Indies in small Sticks & called Stick Lac, ye branches are covered over wt it to a considle degree of thickness, forming an unequal covering over the Sticks, of a dark Orange Colour, it is quite full of Cells, but more irregular than those of Bees Wax; & at ye bottom of the Cell there are ye remains of the Insect, but it is prepared before it comes to the Shops; the Lac is beat off & steeped in Water to extract the Colouring Matter wc is used in dying. What remains is called Seed Lac, consistg of small grains, into wc the Lac breaks when taken forcibly off the Twigs. On other occasions the heat is increased to a greater degree in order to get more of the Colouring Matter wc makes it melt, it rises to the Surface & is scum'd off the Water & cooled in Plates of Metal, & then it is called Shell Lac. — This Substance resembles Bees Wax in several Particulars, but it

has a greater degree of hardness, the greatest part of it dissolves in Sp.t of Wine & forms a remarkably hard Varnish capable of receiving a very fine Polish; but from its dark Colour it is incapable of being employed to colour Works w.ch have a Variety of Colours.

This will serve as a gen.l Acco.t of y.e Unct.s Oils & the Substances approaching most to them.

With reg.d to their Use & Origin, tho' the Aromatic are more precious, these are more valuable & useful; they are produced in greater Q.ty so are of less Price; they are a necessary part of Diet in all parts of the World, in the form of Butter from Milk, of Olive Oil from Vegetables, &c. They also afford us Light in the Night time, & they are one of the Conveniencies contributing to render some Climates habitable; in Lapland they keep their habitations warm by means of them; the Lamp constantly burning is y.e principal part of their household furniture; they are necessary in making Soap; & to

diminish friction in Machines. Many of 'em are useful as Paints & Varnishes to defend Wood from the Air & Water.

They are not confined to the Vegetable Substances but also abounds in the bodies of Animals. In fishes they form a covering, & preserve their heat in that dense & cold Element wc. they inhabit, it being immedly under the Skin. Both in Vegetables & Animals they are secreted Juices; in Vegetables they are often found in the Seed, sometimes in the fruit, they are extracted by various Operations, genly by Expression, as from Seeds; thus Lintseed is ground down to a Meal, & exposed in a strong hair Bag to violent Pressure, & a little heat is employed to give a greater degree of fluidity & facility to its Expression. In other Cases when it can in some measure be dissolved in Water the Substances are infused in Water, as in the Oil of Cloves, &c. and the Oil separates & rises to the top

And all the Animal Oils, as that in ye Cellr Membrane, are soluble in Water by Coction, & this Method is most convenient for extracting these Oils.—

Empyreumatic Oils.

This Term is applied to all Oils distilled with a Heat above that of boiling Water, wn they are made to assume the form of Vapour, they never fail to undergo a Change, they become acrid, stimulating, highly fœtid & disagreeable.

They may be distinguished into 4 Varieties.

1. These produced from the Balsams & Resins.

2d. These from the Unctuous Oils.

3. These from the Vegetable Substances wc dont contain a formed Oil—

4. These from Animal Substances wc are not of an oily Nature.

The 1st Division of these Oils has a burnt & disagreeable flavor, blended with some flavor of the Aromatic Oil. The Balsams & Resins always give out a q[ty] of Aromatic Oil, mixed with the Empyreumatic, from the more fixed part of the resinous Matter, so as to communicate some degree of its particular flavor, so that from Turpentine & some of the Balsams formerly prepared for Medicine, & many of the Empyreumatic Oils obtained from Vegetable Substances abounding with an Empyreumatic Oil may be classed under the same Division.

The 2d. Division has always an Odour more or less resembling y[t] of the Snuff of a Candle or Lamp, from the Wicks of which a q[ty] of Oil evaporates & the Steams mixing with the Air affect our Organ of Smell.

The 3d. Division has more or less of the Odour of Tar, & is not distinguishable from it, & attended w[t]. an Odour of the Acetous Acid, or one approaching to it, or to the Smell of burning Wood.

The 4th Kind has always an Odour resembling that produced by burning bones & other Animal Substances.

These Oils, when first distilled, are always dark Coloured & have a considerable degree of thickness & viscidity, they are easily soluble in Spt. of Wine, & miscible in some measure wt. Water, & they want the lubricating Opacity of the Unctuous Oils. If they are repeatedly distilled they acquire a greater degree of Tenuity, Fluidity, Volatility, & the dark Colour goes off. Many of them can be rendered Colourless fluids & as volatile as Spt. of Wine & they now mix more readily with Water, wh acts chiefly on ye more subtile & volatile part. Here is a Specimen produced from Bees Wax, wh is reckoned to be less acrid & stimulating than most of the other Empyreumatic Oils, it was distilled 5 or 6 times, at first it was somewhat more Colourless, but is now beginng to deposite a qty of dark Coloured Matter as Turpentine does

To give you some Idea of the Odour I shall convert a small q^ty of it into Vapour; it is reckoned one of the least offensive Empyreumatic Oils, it is exactly like y^t of the Wick of a Candle suddenly extinguished. The most fetid are those produced from Animal Substances w^c are not of an oily Nature, — Some of these have been highly recom^d in Medicine, especially those prepared from Animal Substances not of an oily nature, they are recom^d as powerful Anodynes, but the trouble of preparing & y^e difficulty of preserving them have made them less attended to. They must be distilled 5 or 6 times & the Oil put into clean Glass Vessels every time, w^c is attended w^t consid^{ble} trouble & Expence, as it is difficult to free the Vessels of the thicker Matter remaining after y^e Distillat^n, & the excessive fetor of the Oil renders the Operation very disagreable; & when they are prepared they are liable to depreciation by keeping. But, some of them are applied to more expensive

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ever, as Tar. This is the Empyreumatic Oil of the Pine & diff^t. kinds of fir Trees, expelled from them by heat & hastily condensed so as to obtain the greatest q^ty of this Oil, & as these all contain a q^ty of balsamic Matter & Aromatic Oil, the Tar has that adhering to it. The manner of preparing it I ment^d. formerly. A consid^le. q^ty of watery Vapours containg an Acetous Acid is separated from the Wood along w^t. the Tar — When it is boiled to exhale the Water it is called Pitch.

Such is the gen^l. Nature of y^e Empyreumatic Oils ~ The last Division, the

Bitumens,

comprehends all the fossil Inflammables, except Sulphur, w^ch have been described. Some of them are fluid, some Solid — The

Fire damp is among y^e most subtle of them, it is y^e Inflam^ble. Vapour w^ch appears in Mines

Mines of Coals & renders the Working of them dangerous, issuing from the Crevices of the Rocks or Strata, & mixing itself wt. the Air gives it an unwholesome quality. The greatest danger is from its taking fire from the flame of a Candle, wch. is not only inconvenient, as no Work can be done without an artificial Light of this kind, but a considle. qty. of this Air inflamed, has such Violence yt. it has killed the Miners, blown heavy Machinery to considle. height in the Air & destroyed the whole Works. Altho' this Vapour takes fire so readily, it has been discovered yt. it is not liable to be inflamed from Sparks of fire struck from Steel, & in some Mines they use a Wheel of Steel made to turn on a no. of Flints with such Velocity as to throw out a sufft. number of Sparks. In other places they frequy. set fire to it to prevent the Collection of any great qty. This Vapor always collects in the upper part of the Work next to the roof of their Gulleries,

& they can set fire to it by means of a long Stick, or by a String, the ends of w.ch 2 Persons hold at a consid.ble distance. In other places they lay a Pipe where it is observed to issue thro' to the Shaft & from y.t to the external Air, & it is made to terminate in y.e Ash-Pit of a furnace in w.ch a fire is constantly kept, & as the Ashpit has no other Communication with the external Air it occasions a draft of it thro' the Pipe w.ch carries along with it these Inflam.ble Vapours, & in some of y.e Collieries in England the q.ty is so consid.ble y.t it forms a large flame over the Vent of the furnace.

A Vapour of this kind produces some remarkable Phenomena in Italy, as y.e constant boiling observed in some Springs, w.ch a Stranger w.d think to be really boiling, but the Water is cool, yet on the Approach of flame the Surface will immed.ly take fire, & a consid.le flame be nourished there for a long time, for there is a Source of this Vapour

at the bottom of the Spring &c. rising up thro' the Water throws it into an Agitation.

A Vapour similar to this is produced in the Distillation of some Metals, & in the Resolution of Animal & Vegetable Substances by fire, a certain q^ty of Inflam^ble Matter separating & assuming this form.

Next to these in Subtilety are y^e Naphtha & Petrolia. The

Naphtha is an oily Liquor limpid & Colourless like Sp.^t of Wine, very fluid & volatile, with a penetrating smell, so y.^t it will burn on the surface of Cold Water, the smell is rather disagreable; it is highly inflam^ble, but it burns with a Smoake like all other Oils. A Liquor of this Kind is generated from particu-lar Springs & Wells in Persia & in y^e Duchy of Modena in Italy.

Petrolia is another Liquor of this Kind, but inferior, occurring more freq^tly in Italy, Sicily, Bar-bary, France, &c. in the Cravices of Rocks in

Springs & Wells; they are of a browning Colour, have a penetrating Odour, & are highly inflam~ble, many of 'em will burn on ye Surface of cold Water.
Some Bitumens have a Consistence resembling the Vegetable Balsams, as the Pisaleum, Pix Judaica & Asphaltum. I shew you a Species of this kind known under the name of Barbadoes Tar. These differ from one another only in Consistence, Colour & Solubility, & they differ from Petrolia in no other respects. There is a Production of this kind occurring in St Catharines Well between this place & Dalkieth.
These more subtile fossil Oils so rarely occur & are so costly yt few exper.ts have been made upon them. The more fluid float upon Spt of Wine & don't readily dissolve in it; & being mixed with the fossil Acids they produce no violent Effects & acquire a more agreeable Odour; The thicker kind derive their Consistence from a greater qty of solid Matter or Earth, when distilled they become like ye fluid kinds, acquire a greater

Tenuity, Transparency & Volatility.)

Upon the whole, the diffᵗ Varieties, wᶜʰ are said to resemble the Empyreumatic Oils, are obtained by heat from the

Solid Bitumens,

wᶜʰ we are next to consider. Of these there are 2 kinds, first

Amber, Electrum or Succinum. This occurs in considᵇˡᵉ Variety with respect to Colour, some Pieces are clear & transparent, some opaque & whitish, some dark coloured, but the most valued Specimens are of a pale yellow Colour. Upon being slightly rub'd it acquires the power of attracting Straws, & was called Electricity, Spᵗ of Wine dissolves only a small Portion;

Exposed to heat, it gives very remarkable Phenomena, when rub'd the Odour exhaling from it resembles of Aromatic resinous Substances. If the heat is increased it acquires a brown Colour, emits some Steams & undergoes a State of fusion, it is now become quite dark & opaque, & in this

State it is employed in the Composition of some Varnishes, at the same time it emits very penetrating Vapours, wh are found to consist of an Empyreumatic Oil with a small qty of saline Matter, part of wh condenses in ye Neck of the Retort, & another is dissolved in a small qty of Water separated on this occasion.

The Empyreumatic Oil as first produced is mostly thick & of a blackish Colour, & has a heavy penetrating Odour. When repeatedly distilled it becomes more fluid & transparent, & can be rendered quite limpid in wh State it is said to resemble the finer kinds of Petrolia partic'ly the Naphtha. And Margraaf has observed one particular in wh it resembles it very much in its Chemical qualities as well as Odour; when mixed with the nitrous Acid it produces an Effervescence, but is not converted into Vapour, & far less scorched to a Coal, & it acquires an agreeable Odour resembling that of Musk; in its ordinary State the Odour is very

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The Volatile Salt wc. rises is of a very particular kind, & from its condensing in the Neck of the Retort a Chemist wd. conclude it to be a Vol: Alk: but it is found to be an Acid, effervescing with Alkalies & producing Compound Salts. We have some Accts. of its Nature, wc. are not to be depended on. Bourdeline when deflagrating it with Nitre imagined yt he converted it into a Muriatic Acid, obtaining a small portion of common Salt; but others repeating the Expert. have found the Acid of the Amber to be totally destroyed. From this & many other Circumstances it appears to resemble the Vegetable Acids much more than any of the Mineral. And Bourdeline employed a coarse Nitre in this Expt. in wc. the common Salt was present. The Odour of some of the Fossil Oils greatly resembles yt arising when the Oil of Amber is converted into Vapour.

There have been many disputes about the

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Origin of Amber whether it is originally a Fossil, or produced from Vegetable Matter.
The only reason to imagine it to be entirely a fossil body is this, it is found at some depth below the Surface under certain Strata. The greatest part of what we have comes from the Baltic. A considd.e qty is found floating on the Sea, washed out of the Soil by ye Agitation of the Waves on the Coasts where they penetrate thro' diff.t Strata, first thro' one containg fossil Wood variously compacted together, & under this a Stratum of Vitriolic Minerals, below wch the Amber is found dispersed in various Sizes. But,
When examined we find it, from manifest proofs, to have been originally produced on ye Surface of ye Earth & connected with Vegetables, for in the middle of the Pieces we find interspersed numerous little Insects & parts of Vegetables, as Flies, Ants, Spiders, Straws & Leaves of Plants. In the Cabinets of the Curious are innumerable Specimens

-ment of this kind. So it has once been a fluid substance produced at the Surface of the Earth, has incrusted these little Animals, & has been hardened by lying long on the Surface of the Earth, & by the Action of the fossil Acids & other Causes operating upon it.

(2) Ambergrease resembles Amber in several Chemical qualities, tho it differs in its external Appearance & more obvious qualities. It is of a grey Colour, opaque, & of a granulated Structure; has a light agreeable Odour, melts with a gentle heat without suffering any Change; if further heated in close Vessels it gives an Oil like that of Amber. The only other noted quality is to dissolve in Sp^t. of Wine by means of heat, & it is used in the Composition of Perfumes.

Its Origin is not clearly known, but it appears to be somewhat similar to that of Amber. It is found in Masses weighing from 1 to 100 Ounces & more. The greatest q^ty is

found in the Indian Ocean, but we also meet with it in our own & the Northern Seas. It is also found adhering to Rocks & in the stomachs of most voracious fishes, these Animals swallowing at particular times every thing they meet with; We often find in it the Relics of Animal & Vegetable Substances, the bones & beaks of Birds & Insects. And as it resembles Bees Wax in melting, it wd. appear to have been originally Bees Wax, wh. has undergone a considble Change, by having been buried under the Surface of ye Earth or having floated a long time on the Ocean & we know yt. there are amazing quantys of Bees Wax & honey sometimes collected by the Bees in their wild State, as in America in old Trees, in Cavities of the Rocks along the Sea Shore, where large quantys have been found sufficient for filling several Hogsheads wh. being buried or floating on the Water may have been changed or converted into this Substance.

Coal, the last of the solid Bitumens, is well known as a useful fuel. It constitutes numerous Strata in the Bowels of the Earth. It is of various kinds, it wd. be difficult to enumerate the whole, but the chief Distinctions are;

1. The common Hard or Coal.
2. The fat or Blacksmiths Coal.
3. The Kilkenny or blind Coal.

The Parrot Coal differs from the fat Coal in being more Inflamble & burning with a much more copious flame, so contains a larger qty of volatile Inflamble Matter. Exposed to heat in close Vessels it gives out a qty of Empyreumatic Oil, wch by repeated Distillations acquires a great degree of Tenuity at first it is thick & very black, but I've had it as light Coloured as yt of Water & so volatile as to take fire on the approach of the least flame, & on the Surface of Water & so resembled the Naphtha & Petrolia wch were formerly em-

ployed in the Art of War, spread on the Surface of Water & set on fire in order to burn the Enemies Ships.

The Fat Coal contains a great q^ty of Inflam^ble Matter, but in so volatile a State y^t it requires more Art to blow it up, & is disposed to undergo a sort of fusion; the small pieces uniting & concreting together, w^ch is a valuable Property, & what renders the English Coal so valuable in Commerce, because in y^e working & shipping it is not liable to any Waste or decay, the dust of it proving just as useful as the solid pieces, whereas the Coal of this Country of the common kind is not disposed to cake together, the dust of it extinguishes the Fire like Sand. But these first unite together in conseq^ce of y^e partial fusion, & form larger Masses, w^ch are afterwards broke in order to animate the fire.

The Blind Coal is a sort of natural Charcoal, by its external Appearance it is not to be

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distinguished from the other Coal, but in the fire there is a great difference. It does not produce the least appearance of flame, containing the Inflamm.^e Matters in a more fixed State, & exposed to heat in close Vessels it does not give out any Empyreumatic Oil. Some Change has been produced by the Application of Subterranean heat upon the common Kind of Coal, as y^e dissipation of its more Volatile part.

A kind of Coal occurs in very numerous Strata; but upon examg their Appearance in these Strata we find reason to conclude y^t they have derived their Origin from Vegetable Matter. We very freq^tly meet with Appearances so much resembling Charcoal of Wood that there is no room to doubt y^t these Masses have been formed from pieces of Wood w^{ch} have undergone such a Change as to give the Appearance of Charcoal. We see the fibrous Structure & other appearances of y^e Charcoal of Wood, & it possesses the qualities of it except

its having lost the fixed Alkali; & we observe y.t it is found in the Neighbourhood of Strata formed by a Deposition from Water, at least in this part of the World consid.ble quant.s of free Stone & Coal are intermixed, & this is formed of Sand arranged by Water. Besides we find large Collections of Wood below the Surface still retaining its Principles, as near Exeter in Devonshire, only it is so bituminous, y.t it can't be made use of for ordinary fuel, but is only employed for burning Lime; & in other parts we find amazing quant.s of Wood; as Trees, compacted together & forming very thick & extensive Strata.

These, with many other Phenomena, shew that this Globe has undergone great Changes, that what was once above the Surface is now buried at a great depth, & what was formerly at a great depth is now exposed to y.e Air. So we find reason to conclude with regard to the fossil Inflam.ble Substances that they

have all derived their Origin from Vegetables. The first traces of these in Amber &c. and with reg.d to the fluid Inflam.bles they resemble the Empyreumatic Oils & are probably produced by the destruction of Inflamable Substances by subterraneous heat, & we finds them in Countries abounding with Vulcanoes, as in Italy, where the different kinds of Petrolia & Naphtha issue from the Crevices of Rocks & float on the Waters of particular Springs, & the whole of the Country has either subterraneous fires at present, or Marks of fires w.ch formerly existed.

With this we finish the Acco.t of the Inflammable Substances, & next begin with the Metals

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BLAIR'S
LECTURES

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